CUS-0329
COPY / OF /

[redacted] PROGRESS REPORT NO. 2
1-28 MAY 1959

STAT

ENGINEERING REPORT NO. 5442
28 MAY 1959

PROJECT ENGINEER [redacted]

STAT

CHIEF ENGINEER ______________
Roderic M. Scott

Report prepared by:
[redacted]

STAT

COPY NO. ______

NUMBER OF PAGES 54+ii

2a

SUMMARY

This report consists of three sections: (1) The second monthly progress report; (2) a comparison of several systems; and (3) a proposal to extend the Engineering Study.

The progress report covers the period 1-28 May, reporting on the same categories of activity as the first report.

The comparison of several systems presents a tabular summary of parameters as well as a discussion of some salient considerations, both general and specific. A recommendation as to the best type of system, the twin-camera panoramic scanning type, is made.

In the last section of this report, the value of continuing the Engineering Study and initiating the Engineering Design without an interruption at 30 June 1959 is discussed, and it is proposed that an extended program be implemented prior to the conclusion of the present activity on 30 June 1959.

INDEX

Declassified in Part - Sanitized Copy Approved for Release 2012/06/18 : CIA-RDP89B00487R000400730032-7

MAY PROGRESS

ACTIVITIES

Our activities have been classified into three categories, roughly according to priority:

(1) Those problems to which effort must be applied immediately

(2) Those problems to which solutions should be obtained before a final system selection is made

(3) Those problems to which solutions should be obtained after the final system selection, but before June 30, 1959

The problems are listed below with statements of work done and specifically planned work.

CATEGORY 1

LIAISON [redacted] visited the Vehicle Contractor on 14 May. Although payload location was the principal point of discussion, vibration and stabilization of the vehicle, electrical shielding of the window, and bay environment were also considered. STAT

LENS DESIGNS Ray trace computations were programmed and performed for the shell-Schmidt system. Other designs, more familiar to the Optical Designers, have not required programming. The most promising designs are described in the tabulation section of this report.

MODULATION TRANSFER FUNCTIONS FOR LENS-FILM These have been calculated for all systems, and appear in Appendix A.

SPECIFY LENS The best lenses for the various configurations have been selected, and are listed in the tabulation section of this report. Final selection is to be made after further consideration.

AERIAL SCENE SPECTRA All purchased parts have been received. The apparatus is 90% complete. The first tests should be run late this week or early next week. Aerial scenes have been received.

WINDOW The window investigation is progressing satisfactorily along the lines outlined in the previous progress report.

CAMERA ARRANGEMENT IN BAY The general layout of each system has been made. Until mockups of the selected bay and system are made, it will be impossible to say with assurance that mechanical compromises will not be required. However, the tabulated systems should fit in the specified volumes.

STRUCTURAL DESIGN No work to date

FILM TRANSPORT No work to date

BAY ENVIRONMENT Discussed with vehicle contractor

VIBRATION CONTROL METHODS A contract with the vibration consultants has been written, and they are establishing principles for the isolation of systems with either two or three axis stabilization.

V/H SENSOR Several methods, including the one described in Engineering Report 5394 have been investigated and found to be feasible. A simple system using a grid may be usable. This will depend upon the scene spectra, which will be known as a result of the Aerial scene investigation. A visit was made to the Avion Division of ACF at Paramus, New Jersey. A working breadboard of a V/H sensor was examined. This sensor could possibly be applied to this program in a modified form. Companies known to manufacture V/H sensors will be solicited to ascertain the possibility of obtaining an existing component or system.

STABILIZATION Components capable of sensing changes in rate and position much smaller than will be needed have been found to exist. The problem to resolve, therefore, is that of the stabilization loop dynamics. Until a final system is chosen, this cannot be done.

RELIABILITY CONTROL METHODS The outline of a reliability programs has been made and will be further expanded.

SERVOMECHANISMS So far all necessary components have been found to be either purchasable hardware or practical modifications of existing components.

POSITIONING METHODS No further activity in May.

ELECTRICAL COOLING Spot colling by thermoelectric methods is practical, and hardware can be procured. There are limits to the volumes which can be cooled by this method. At the present time generation of electrical power from excess vehicle heat is theoretically possible, but not too practical.

CATEGORY 2

FILM SELECTION Kodak films are known, and we are still awaiting information from Ansco. The May 13th meeting with Dupont was held as scheduled. Our requirements were stated and the theory of response curves was discussed. A two part program was agreed upon:

Part I-Dupont will investigate their present emulsions and determine what, if anything, can be modified to meet our needs. Part II-A further meeting will be held at their laboratories to discuss a research program to develop a new emulsion, and to set up instrumentation for measuring response characteristics of film.

It was their "unofficial" feeling that a suitable emulsion seems realistic for a year from now.

NADIR INDICATION	No activity in May
PREFLIGHT TEST METHODS	No activity in May
PROGRAMMING ORDER	No activity in May
CYCLING METHOD	No activity in May

CAMERA MODULATION FUNCTION These have been estimated for all systems, and are shown in Appendix A.

SCANNING METHOD Indicated in tabulation.

IMC METHOD Indicated in tabulation. Details must be worked out in selected system.

POSITIONING TOLERANCES	No activity in May
AUTOBALANCE	No activity in May

MAGNETIC FILM The application of magnetic films on Cronar bases seems feasible for our application according to preliminary discussion with Dupont.

VIBRATION ISOLATION DESIGN	No work yet. Specification will be ready by 30 June.
WEIGHT ESTIMATE	Provided for in tabulation.
SLIT DESIGN	No activity in May
LIGHT SEALS	No activity in May
CATEGORY 3	
POWER CONVERSION	No activity in May
POWER REGULATION	No activity in May
CONTROL PANEL	No activity in May
DATA CHAMBER	No activity in May
TEMPERATURE CONTROLS	No activity in May
12 MONTH PROGRAM	Preliminary outline has been made.
12 MONTH PERSONNEL	No activity in May
12 MONTH COSTS	No activity in May
EXPOSURE CONTROL METHOD SENSOR	No activity in May
AUTOMATIC FOCUS SPECIFICATION	No activity in May
CATOGRAPHIC FEATURES	No activity in May
FAIL SAFE CONTROL	No activity in May
CAGING METHODS	No activity in May

PROGRAM ORGANIZATION

The core of the Engineering group eventually required is now at work on the program. The personnel are:

R. M. Scott - Vice President, Reconnaissance & Program Director

[redacted] - Physicist & Project Engineer

STAT

[redacted] - Optical Physicist

[redacted] Optical Engineer, Windows

[redacted] Optical Engineer, Aerial Spectra

[redacted] - Electronic Engineer

[redacted] - Junior Electronic Engineer

- Lead Designer

Engineering Control Coordinator

The scheduled and applied hours are shown in Figure 1.

CATEGORY		4-17	4-24	5-1	5-8	5-15	5-22	5-29	6-5	6-12	6-19	6-26	6-30
[illegible] Engr	Est. Hours	56	84	156	124	132	124	124	156	156	156	172	64
	Act. "	12	12	32.5	10	9							
	Est. Cuml. Hrs.	56	140	296	420	552	676	800	956	1112	1268	1440	1504
	Act. " "	12	24	56.5	66.5	75.5							
[illegible] Engr	Est. Hours	76	80	80	80	80	80	80	100	100	120	120	56
	Act. "	62	76	69.5	72.5	104							
	Est. Cuml. Hrs.	76	156	236	316	396	476	556	656	756	876	996	1052
	Act. " "	62	138	207.5	280	384							
[illegible] Engr	Est. Hours	0	40	80	80	80	80	80	80	80	80	80	32
	Act. "	0	48	99	149	173.5							
	Est. Cuml. Hrs	0	40	120	200	280	360	440	520	600	680	760	792
	Act. " "	0	48	147	296	469.5							
Jr. Engr	Est. Hours	0	0	40	40	40	60	60	80	80	80	80	32
	Act. "	12	8	39	45	44.5							
	Est. Cuml. Hrs	0	0	40	80	120	180	240	320	400	480	560	592
	Act. " "	12	20	59	104	148.5							
Opt. Des	Est. Hours	0	20	20	0	0	0	20	40	40	0	0	0
	Act. "	0	8	15	21	18							
	Est. Cuml. Hrs	0	20	40	40	40	40	60	100	140	140	140	140
	Act. " "	0	8	23	44	62							
Design	Est. Hours	0	8	40	40	40	40	52	80	80	80	80	32
	Act. "	0	0	45	45	36							
	Est. Cuml. Hrs.	0	8	48	88	128	168	220	300	380	460	540	572
	Act. " "	0	0	45	90	126							
Detail	Est. Hours	0	0	0	0	0	0	0	80	80	80	80	32
	Act. "	0	0	0	0	0							
	Est. Cuml. Hrs	0	0	0	0	0	0	0	80	160	240	320	352
	Act. " "	0	0	0	0	0							
Check	Est. Hours	0	0	20	20	20	20	20	20	20	20	0	0
	Act. "	0	0	0	23	157.7							
	Est. Cuml. Hrs	0	0	20	40	60	80	100	120	140	160	160	160
	Act. " "	0	0	0	23	180.7							

[illegible] 5442 FIGURE 1

Declassified in Part - Sanitized Copy Approved for Release 2012/06/18 : CIA-RDP89B00487R000400730032-7

ANALYSIS AND RECOMMENDATION

SUMMARY

The study activity to date has been directed toward the general definition of a special purpose photographic reconnaissance system. The performance specification for this system consists of four principal parts: (1) Ground resolution of one foot; (2) high reliability; (3) small size (to fit within specified volumes, as shown in Appendix B); and (4) large area coverage. The value judgements applied in our study have been to rate operational resolution as the pre-eminent characteristic. However, this has been substantially tempered by the other specifications, particularly size. Within these limitations, ten systems have been considered, and the parameters of these systems are tabulated in Figures 2, 3, 4 and 5.

In view of the importance of the operational resolution capability factor, this information has been recorded for each system and is presented in Figures 6 and 7. For comparison with the systems under consideration, similar data is also presented showing the resolution capability of the existing B configuration. This comparison data for the B configuration is drawn in two curves; one representing resolution capabilities of the B under similar altitude conditions as those under which all the other systems are considered, labeled B system, new vehicle, and the other, labeled B system, old vehicle, representing its present resolution capabilities.

Figure 7, which is an expanded version of Figure 6, shows resolution in feet on the ground, as a function of object modulation (contrast). Examination of Figure 7 shows that system 4A, the 22-inch f/2 Flugge system is capable of the highest resolution. For a high contrast object,

the analysis indicates that this system will resolve 1.1 feet on the ground; while for a medium contrast object (.78), it will resolve 1.2 feet on the ground. Figure 7 allows a comparison to be made of the relative merits of each system from a resolution point of view.

The transfer functions from which these curves have been developed are contained in Appendix A, and represent our best engineering judgement at this time. It is important to emphasize that the predictions contained in Figures 6 and 7 are estimates and must necessarily remain so until a great mass of experimental data can be obtained. Naturally, the curves will be modified from time to time to conform to the most recent accurate information available.

SPECIAL LIMITATIONS

There are two special limitations, one physical and one practical, which could greatly alter the performance predictions. Both of these are receiving attention.

The first limitation is seeing, which encompasses optical deterioration due to atmospheric, boundary layer and window effects. The resultant degradation due to this cause has been estimated (to an order of magnitude) and present analysis indicates that this may be a slight limitation on resolution performance capability. Until the actual vehicle is in operation, the best that can be done is to further consider the atmospheric and boundary layer effects from a theoretical point of view and the window effects by a theoretical and experimental analysis. An experimental program is under way.

The second limitation is that of passively sensing V/H rates. Investigations indicate that present components give good reason for optimism for achieving a workable system capable of the required one percent accuracy.

If information is obtained to grossly alter our present evaluation of these limitations, a re-estimate of performance will be submitted.

SPECIFIC SYSTEMS

Reference is once again made to Figures 2, 3, 4 and 5, which tabulate the salient features of the several systems considered. System 1-A is the system discussed in Engineering Report 5394; system 4-A is a scaled-up version of it; and systems 1-C and 4-C merely employ different lenses in the same general configuration. (See Appendix C.)

A method, described in Engineering Report 5394, was developed which permitted constant film transport. This method was based on the fact that the lens cell would rotate about a point other than its center of gravity. However, at least in the case of system 1-A, due to space limitations, the lens cell must rotate about its center of gravity. This will require mechanization of inconstant film transport. There are factors which indicate that for the 1-A system, it might be easier to mechanize an inconstant film transport than to attempt to rotate the cell about a point other than its center of gravity, regardless of the space limitation. System 4-A, which is not space limited, may more easily adapt to mechanization affording constant film transport. Systems 1-C and 4-A have the center of gravity close to the desired point of rotation, and therefore may be easy to mechanize.

Systems 1-B and 4-B are scaled-down versions of the shell-Schmidt proposed by JGB in a letter dated 30 March 1959. A comprehensive optical analysis of the 24-inch f/6 shell-Schmidt lens is contained in Appendix D. The problems of vibration, film deformation to a spherical focal surface, and shuttering still appear prohibitive.

Systems 2-A and 3-A are typical of the type of system dictated by the volumes for which they are proposed. Since both volumes severely restrict scanning capability, transverse coverage is provided by the lens field-of-view. In the case of Volume 2, the system must lie on its side, and a 45°- flat mirror provides downward viewing; and consequently a small aperture is desirable to permit a small mirror.

RECOMMENDATION

The twin-camera panoramic scanning system, as described in Engineering Report 5394, is recommended. The advantages of this type system are impressive: (1) Two photographic units, providing additional insurance against incomplete mission coverage; (2) no shutter or vacuum platen; (3) convergent photography; and (4) narrow field lenses which have inherently high performance. The choice of a particular refracting or reflecting lens for this system will be made after the problems of film transport and scanning have been considered along with the choice of photographic scale.

The specific problem, mentioned in Engineering Report 5394, of suitably baffling the Flugge lens has been solved so successfully that it provides higher performance off-axis than on-axis. The general problems of seeing, sensing V/H accurately, and film transport are common to all systems, and are neither more nor less troublesome with the recommended systems than with the other systems.

The question of which system can be employed depends, in part, on the volume selected. Naturally, all other things being equal, the largest volume is most attractive from the point of view of the reconnaissance system. Consideration must also be given to the effect that volume choice has upon vehicle performance and operation.

It is our understanding that the choice of volume 4 could place a considerable hardship upon vehicle performance. Inasmuch as the differences in the performance predictions of the several reconnaissance systems are within the accuracy of prediction, and since the difference in predicted performance levels for the 17.5 and 22-inch Flugge lens systems is relatively small, it seems appropriate to base the decision largely on vehicle expediency. This leads us to suggest use of volume 1 or a volume between volume 1 or volume 4 (from station 96 to 144). However, this choice is outside our jurisdiction; although we are both willing and desirous of participating in discussions leading to a final selection.

SYSTEM / PARAMETERS	1A TWIN 17.5" f/2 FLÜGGE (ENG. REPORT 5394)	1B 18" f/6 BAKER SHELL-SCHMIDT	1C 6" f/2 REFR. BALL	PETZVAL	2A 24" f/6	3A 24" f/3.5	4A 22" f/2 FLÜGGE (ENG. REPORT 5394)	4B 24" f/6 BAKER SHELL-SCHMIDT	4C 9" f/2 REFR. BALL	PETZVAL
VOLUME	1				2	3	4			
FOCAL LENGTH	17.5"	18"	6"		24"	24"	22"	24"	9"	
FILM TYPE	SO-243	SO-182	SO-243		SO-182	SO-243	SO-243	SO-182	SO-243	
FILM SPEED (ASA)	2.5	12	2.5		12	2.5	2.5	12	2.5	
EXPOSURE TIME / SEC.	1/100	1/120	1/180	1/200	1/120	1/75	1/100	1/120	1/180	1/200
T-NUMBER	T/3.3 (44% TRANS)	T/6.6 (91% TRANS.)	T/2.5 (58% TRANS.)	T/2.4 (68% TRANS.)	T/6.7 (80% TRANS.)	T/3.8 (92% TRANS.)	T/3.3 (44% TRANS.)	T/6.6 (91% TRANS.)	T/2.5 (58% TRANS)	T/2.4 (68% TRANS.)
f-NUMBER	f/2	f/6	f/2		f/6	f/3.5	f/2	f/6	f/2	
FOCAL SURFACE CHARACTERISTICS	FLAT 70 MM	4.5"X19" SECTION OF 18" RADIUS SPHERE	FLAT (FIELD FLATTNER) 24 MM		FLAT 18"X9"	FLAT 18"X9"	FLAT 3.34" WIDE 85MM	6"X25.2" SECTION OF 24" RADIUS SPHERE	FLAT (FIELD FLATTNER) 35 MM	
ABERRATIONS	EXTREMELY SMALL SECONDARY COLOR APPROX. 1/10 OF CONVENTIONAL LENS	NEARLY DIFFRACTION LIMITED	BAD SECONDARY SPECTRUM	CHROMATIC ABERRATION 1/4 OF CONVENTIONAL LENS	NO KNOWN DESIGN DATA AVAILABLE	APOCHROMATIC	EXTREMELY SMALL SECONDARY COLOR APPROX. 1/10 OF CONVENTIONAL LENS.	NEARLY DIFFRACTION LIMITED	BAD SECONDARY SPECTRUM	CHROMATIC ABERRATION 1/4 OF CONVENTIONAL LENS
LENS FIELD OF VIEW	8.7°	60°X14.3°	9°	9°	41°X21°	41°X21°	8.7°	60°X14.3°	9°	9°

FIGURE 2 OPTICAL CONSIDERATIONS

ENG NO 544

SYSTEM / PARAMETERS	1A TWIN 17.5" f/2 FLUGGE (ENG. REPORT 5394)	1B 18" f/6 BAKER SHELL-SCHMIDT	1C 6" f/2 REFR. BALL		2A 24" f/6	3A 24" f/3.5	4A 22" f/2 FLUGGE (ENG. REPORT 5394)	4B 24" f/6 BAKER SHELL-SCHMIDT	4C 9" f/2 REFR. BALL	
			BALL	PETZVAL					BALL	PETZVAL
TUBE LENGTH	13"	36"	9.5"	10"	30"	30"	16.5"	48"	14"	15"
TUBE DIAMETER	13"	36" X 15"	4"	4"	14"	14"	16.5"	48" X 20"	6"	6"
DEPTH OF FOCUS	.0003"	.00025"	.0003"	.0003"	.001" OBLIQUITY LIMITATION	.001" OBLIQUITY LIMITATION	.0003"	.00025" OBLIQUITY LIMITATION	.0003"	.0003"
FILM CAPACITY	4100 FT. 70MM WIDE	5600 FT. 4.5" WIDE	1900 FT. 24MM	1900 FT. 24 MM	1900 FT. 9" WIDE	3600 FT. 18" WIDE	6400 FT. 3.5" WIDE	4000 FT. 6" WIDE	2800 FT 35MM	2800 FT 35 MM
FILM SPOOL DIAMETER	17" DIA.	20" DIA.	12" DIA.	12" DIA.	12" DIA.	16" DIA.	21.4" DIA.	17" DIA.	14" DIA.	14" DIA.
SHUTTER	SLIT AT FOCAL SURFACE	FOCAL PLANE	SLIT AT FOCAL SURFACE		BETWEEN THE LENS	BETWEEN THE LENS OR FOCAL PLANE	SLIT AT FOCAL SURFACE	FOCAL PLANE TYPE	SLIT AT FOCAL SURFACE	
WINDOW SIZE	26" X 36"	9" X 9"	18" X 13"		8" X 10"	16" DIA.	30" X 40"	12" X 12"	26" X 16"	

FIGURE 3 MECHANICAL CONSIDERATION ENG. NO 5442

SYSTEM / PARAMETERS	1A TWIN 17.5" f/2 FLUGGE (ENG. REPORT 5394)	1B 18" f/6 BAKER SHELL-SCHMIDT	1C 6" f/2 REFR.		2A 24" f/6	3A 24" f/3.5	4A 22" f/2 FLÜGGE (ENG. REPORT 5394)	4B 24" f/6 BAKER SHELL-SCHMIDT	4C 9" f/2 REFR.	
			BALL	PETZVAL					BALL	[illegible]
COVERAGE METHOD	ALTERNATE UNIT SCAN PERPENDICULAR TO OPTIC AXIS ABOUT LENS-CELL CENTER OF GRAVITY	SEQUENTIAL VERTICAL PHOTOGRAPHS. TRANSVERSE COVERAGE OF 60° DUE TO LENS FIELD	ALTERNATE UNIT SCAN PERPENDICULAR TO OPTIC AXIS ABOUT POINT IN FRONT OF REAR NODAL POINT, BUT CLOSE TO CENTER OF GRAVITY		SEQUENTIAL VERTICAL PHOTOGRAPHS. FORWARD OVERLAP 40%. TRANSVERSE COVERAGE OF 41° (TOTAL) DUE TO FIELD OF LENS	SEQUENTIAL VERTICAL PHOTOGRAPHS. FORWARD OVERLAP 60%. TRANSVERSE COVERAGE OF 41° (TOTAL) DUE TO FIELD OF LENS	ALTERNATE UNIT SCAN PERPENDICULAR TO OPTIC AXIS ABOUT POINT IN FRONT OF FIRST ELEMENT	SEQUENTIAL VERTICAL PHOTOGRAPHS. FORWARD OVERLAP 20% TRANSVERSE COVERAGE OF 60° DUE TO LENS FIELD	ALTERNATE UNIT SCAN PERPENDICULAR TO OPTIC AXIS ABOUT POINT IN FRONT OF REAR NODAL POINT, BUT CLOSE TO CENTER OF GRAVITY	
IMC METHOD	LENS ROTATION AND FILM MOTION	ROCK WHOLE UNIT NO 2ND ORDER COMPENSATION CAN BE APPLIED AT EDGE OF FIELD	LENS ROTATION AND FILM MOTION		ROTATING 45° MIRROR IN FRONT OF SYSTEM	SWINGING MOUNT	LENS ROTATION AND FILM MOTION	ROCK WHOLE UNIT NO 2ND ORDER COMPENSATION. CAN BE APPLIED AT EDGE OF FIELD	LENS ROTATION AND FILM MOTION	
FILM VELOCITY (AVERAGE)	8.0 IN/SEC.	4.2 IN/SEC.	3.9 IN/SEC.	3.9 IN/SEC.	3.9 IN/SEC.	2.8 IN/SEC.	12.5 IN/SEC.	5.6 IN/SEC.	5.3 IN/SEC.	5.3 IN/SEC.
CYCLING TIME (SEC.)	2.9	4.7	3	3	5.2	3.5	2.9	4.7	3	3
FILM TRANSPORT METHOD	INTERMITTENT	INTERMITTENT	CONSTANT RELATIVE TO BAY, AND TWO CONSTANT RATES RELATIVE TO SLIT		INTERMITTENT	INTERMITTENT	CONSTANT RELATIVE TO BAY, AND TWO CONSTANT RATES RELATIVE TO SLIT	INTERMITTENT	CONSTANT RELATIVE TO BAY, AND TWO [illegible] RATES RELATIVE TO [illegible]	
SPECIAL NOTES	TWO PHOTOGRAPHIC UNITS FRONT ELEMENT HAS DOUBLE CURVES BOTH REFLECTING SURFACES ARE MECHANICALLY SENSITIVE NO AUTOBALANCE REQUIRED	FK-5 IS CLASS 4 GLASS CURVED FOCAL PLANE	COMPACT. STRUCTURE CANNOT TAKE EXCESS TEMPERATURE CHANGE	APOCHROMATIC REQUIRES KzFS4 GLASS WHICH HAS TEMPERATURE COEFFICIENT MARKEDLY DIFFERENT FROM OTHER GLASSES AND IS IN CLASS 5C	NO KNOWN DESIGN DATA AVAILABLE	TWO KNOWN DESIGNS ARE AVAILABLE ONE IS AN APOCHROMAT AND ONE IS A SIMPLIFIED VERSION	TWO PHOTOGRAPHIC UNITS FRONT ELEMENT HAS DOUBLE CURVES BOTH REFLECTING SURFACES ARE MECHANICALLY SENSITIVE FRONT ELEMENT IS LARGE	FK-5 IS CLASS 4 GLASS CURVED FOCAL PLANE	COMPACT STRUCTURE CANNOT TAKE EXCESS TEMPERATURE CHANGE	[illegible] GLASSES AND IS IN CLASS 5C
MISSION GROUND COVERAGE	4000X20.8 NMI 60% STEREO OVERLAP WITH 20° CONVERGENCE	4000X17.2 NMI 66% FORWARD OVERLAP	4000X29.5 NMI 60% STEREO OVERLAP WITH 20° CONVERGENCE		4000X4.95 NMI 40% FORWARD OVERLAP	9500X4.95 NMI 60% FORWARD OVERLAP	4000X29.5 NMI 60% STEREO OVERLAP WITH 20° CONVERGENCE	4100X17.2 NMI 20% FORWARD OVERLAP	4000X29.5 NMI 60% STEREO OVERLAP WITH 20° CONVERGENCE	

FIGURE 4 DESCRIPTIVE CONSIDERATIONS.

FNC NO. 5[illegible]

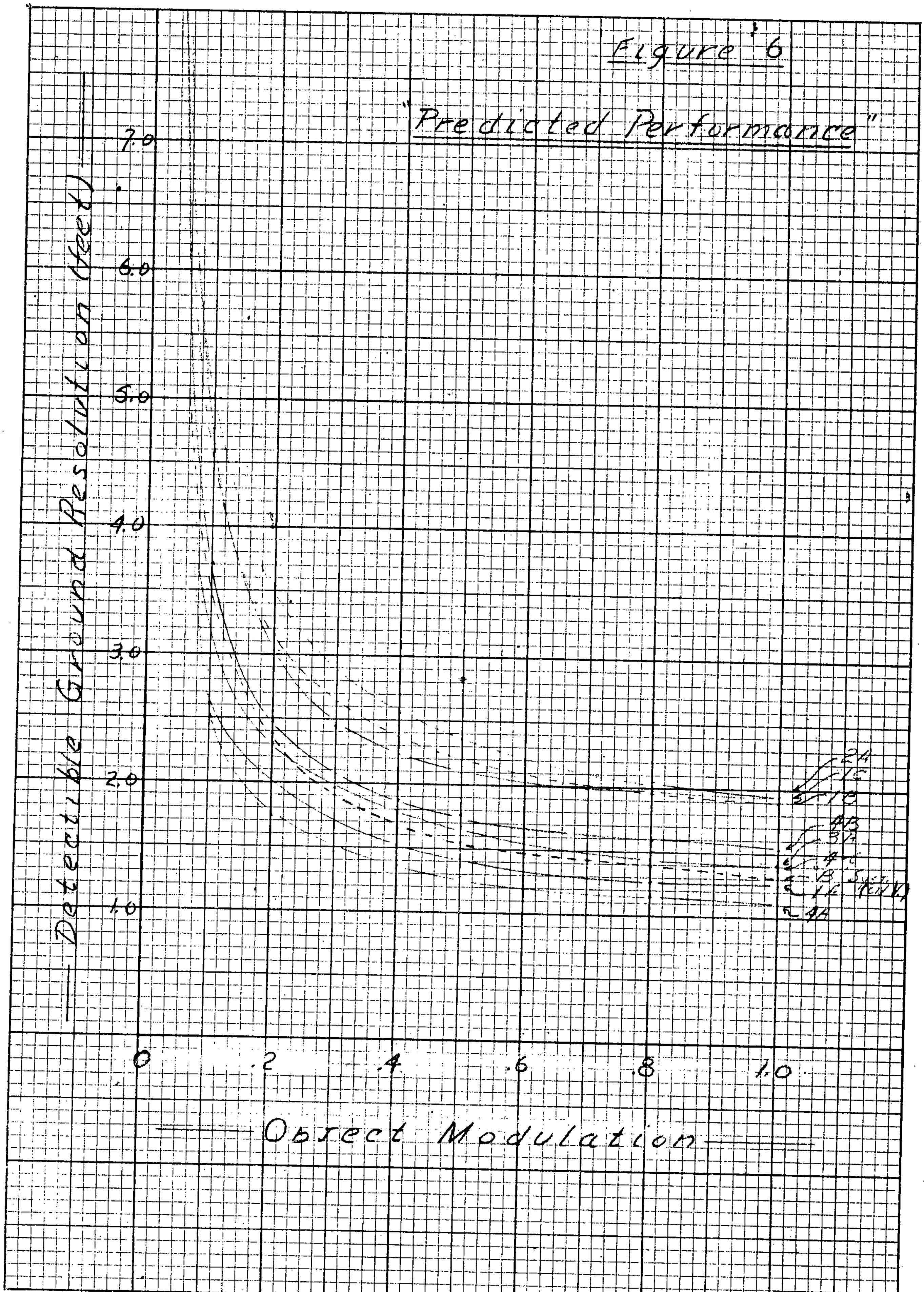
SYSTEM / PARAMETERS	1A TWIN 17.5" f/2 FLUGGE (ENG. REPORT 5394)	1B 18" f/6 BAKER SHELL-SCHMIDT	1C 6" f/2 REFR. BALL	1C 6" f/2 REFR. PETZVAL	2A 24" f/6	3A 24" f/3.5	4A 22" f/2 FLUGGE (ENG. REPORT 5394)	4B 24" f/6 BAKER SHELL SCHMIDT	4C 9" f/2 REFR. BALL	4C 9" f/2 REFR. PETZVAL
GLASS	45	40	20	10	90	80	95	70	35	20
CELL	30	30	35	35	60	40	60	50	60	55
IMC COMPONENT	20	20	20	20	50	100	25	25	20	80
FILM	45	55	10	10	35	130 (9500 NMI) 55 (4000 NMI)	90	50	20	20
FILM TRANSPORT SYSTEM	30	40	20	20	20	20	40	50	25	25
SHUTTER	5	25	5	5	20	20	5	30	5	5
STABILIZER	100	120	80	80	25	20	150	125	120	120
MISCELLANEOUS (V/H AUTO-BALANCE EXP. CONTROL, FOCUS CONTROL CAGING, ETC.)	60	40	60	60	20	20	70	50	70	70
SYSTEM (EXCLUDING WINDOW)	335	370	250	240	320	355 (4000NMI)	535	450	335	335
WINDOW (GLASS ONLY)	185	15	40	40	15	30	240	25	70	70

FIGURE 5 WEIGHT CONSIDERATIONS

Declassified in Part - Sanitized Copy Approved for Release 2012/06/18 : CIA-RDP89B00487R000400730032-7

Figure 6

"Predicted Performance"



Declassified in Part - Sanitized Copy Approved for Release 2012/06/18 : CIA-RDP89B00487R000400730032-7

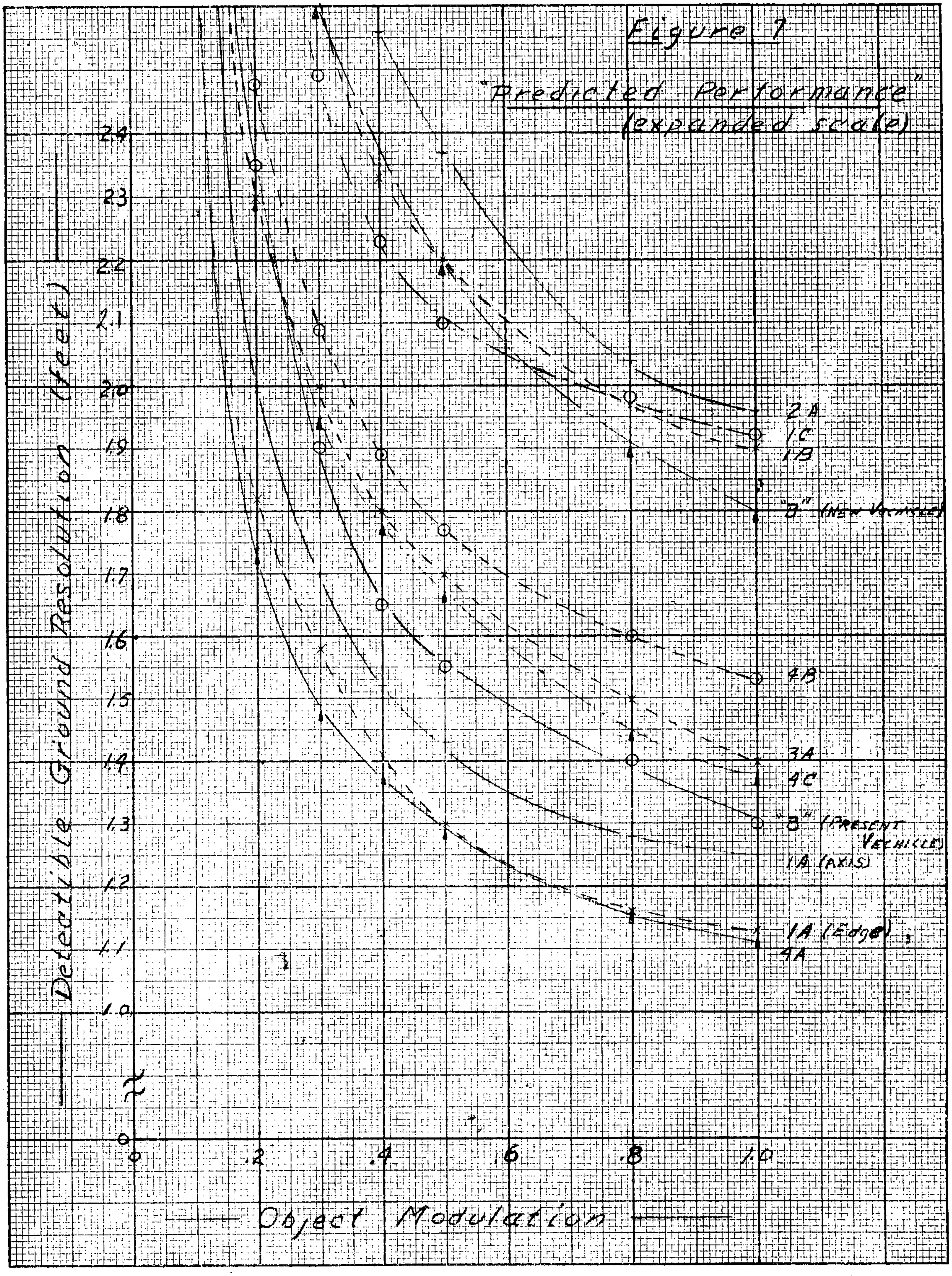


Figure 7
"Predicted Performance"
(expanded scale)
Detectible Ground Resolution (feet)
Object Modulation
2.4
2.3
2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0
0
.2
.4
.6
.8
1.0
2A
1C
1B
"B" (NEW VEHICLE)
4B
3A
4C
"B" (PRESENT VECHICLE)
1A (AXIS)
1A (Edge)
4A

PROPOSED PROGRAM EXTENSION

BACKGROUND

The present Engineering Study is scheduled to end 30 June 1959 with the establishment of the principles and overall design concepts for a photographic reconnaissance system of maximum capability. Following this, about one year is available in which to design, manufacture, and assemble the system.

PROPOSAL

Since the period for design, manufacture and assembly is short, it is our feeling that we should commence that activity on 1 July. To permit this, it is proposed that the present contract be extended now to cover Engineering Design work during the period 1 July - 30 September 1959. (All personnel take vacation 1-16 August 1959, so it is an eleven week work period.)

During this period, experimental activities will be expanded to include Engineering breadboards and mockups. Design work will commence on the particular system selected during June, and some of the detailed manufacturing drawings - particularly those for long lead items - will be completed.

Liaison with the vehicle contractor, film manufacturers, and the customer will be continued. Reports will be submitted 31 July, 4 September and 30 September.

APPENDIX A:

MODULATION TRANSFER FUNCTIONS

FIGURE	SYSTEM	
8	1-A	17.5" f/2 Flügge
9	1-B	18" f/6 Shell-Schmidt
10	1-C	6" f/2 Ball or Petzval
11	2-A	24" f/6 Aerial
12	3-A	24" f/3.5 Aerial
13	4-A	22" f/2 Flügge
14	4-B	24" f/6 Shell-Schmidt
15	4-C	9" f/2 Ball or Petzval
16		B System

Declassified in Part - Sanitized Copy Approved for Release 2012/06/18 : CIA-RDP89B00487R000400730032-7

FIGURE 8 :

Modulation Transfer Characteristics for System 1-A (AXIS)

CURVE
A Diffraction Limit
B Film SO-243
C Seeing 1.25" BOUNDARY LAYER & 17.5' F.L.
D Vibration .0001"
E Stabilization 1/500 MM
F System

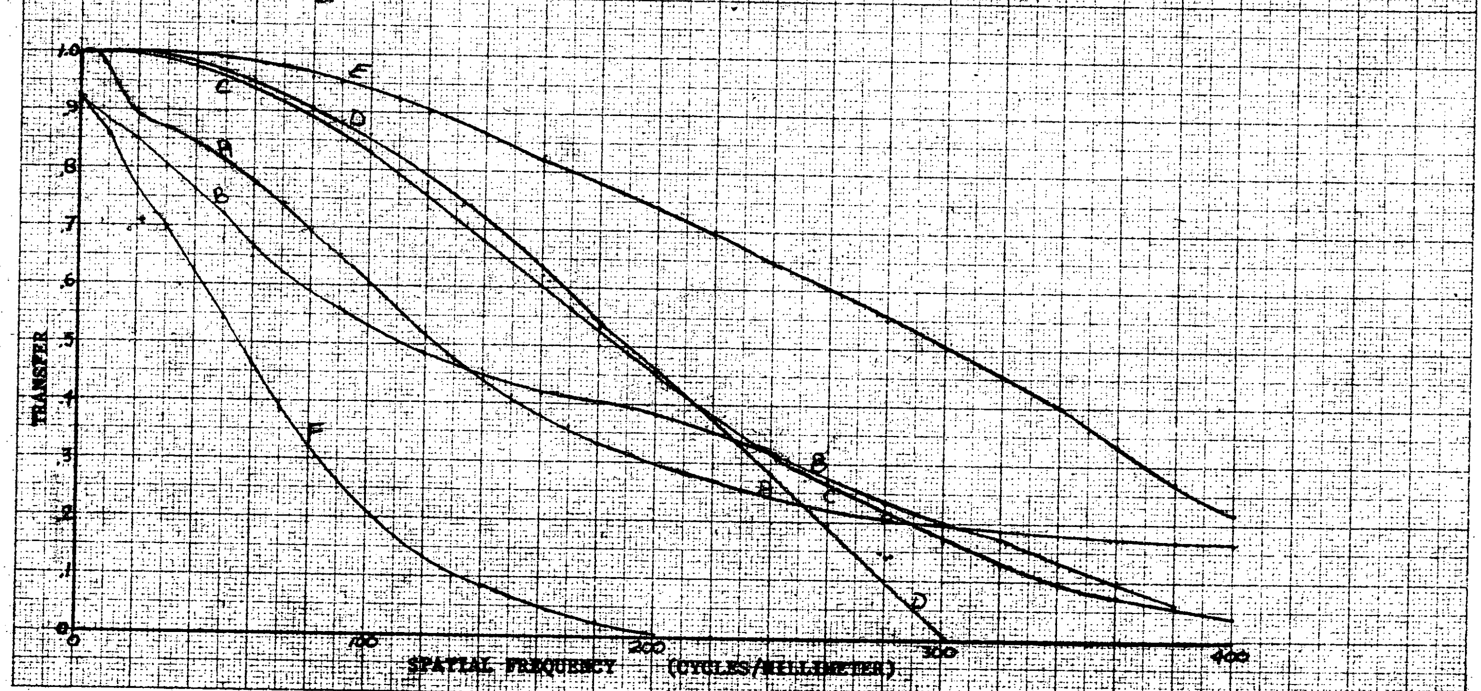


FIGURE 8A:

Modulation Transfer Characteristics for System I-A (4.5° OFF AXIS, TANGENTIAL)

CURVE

A Diffraction Limit
B Film SO-243
C Seeing 1.25" BOUNDARY LAYER @ 17.5" F.L.
D Vibration .0001"
E Stabilization 1/500 MM
F System

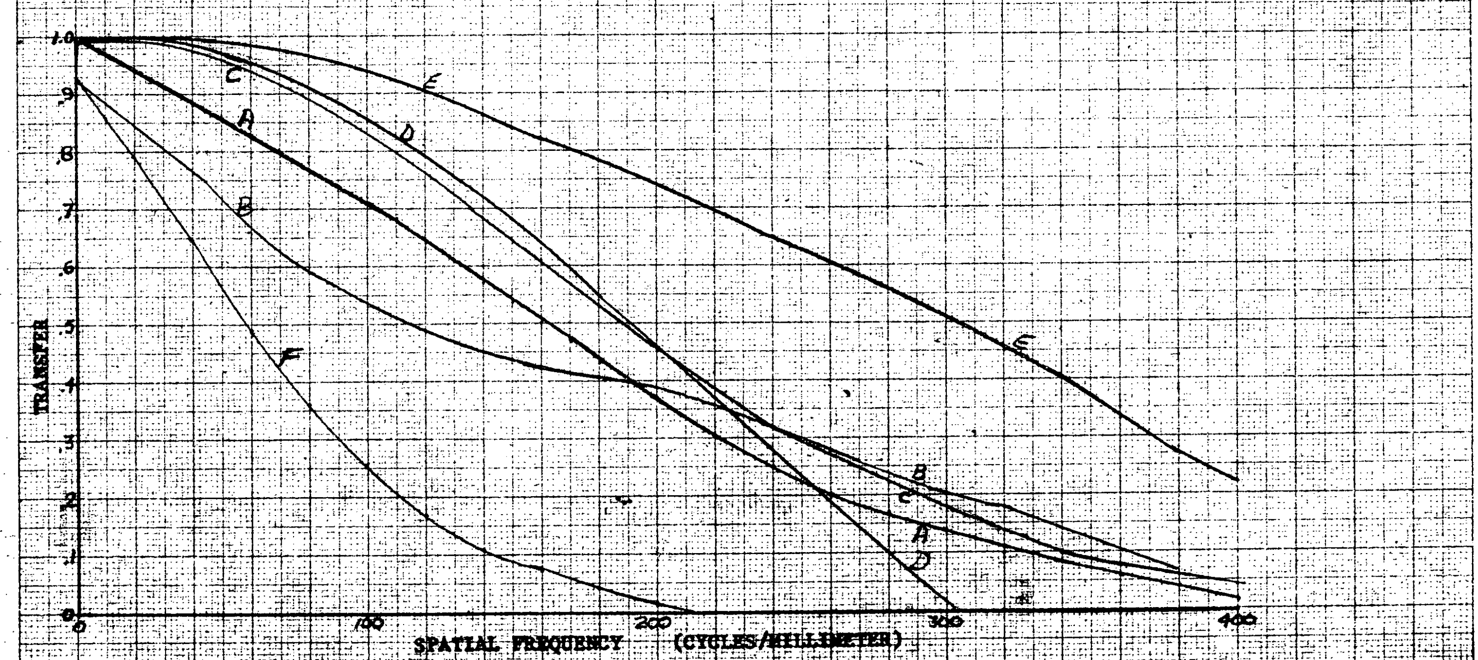


FIGURE 8-B:
Modulation Transfer Characteristics
for System 1-A (4.5° OFF AXIS, RADIAL)

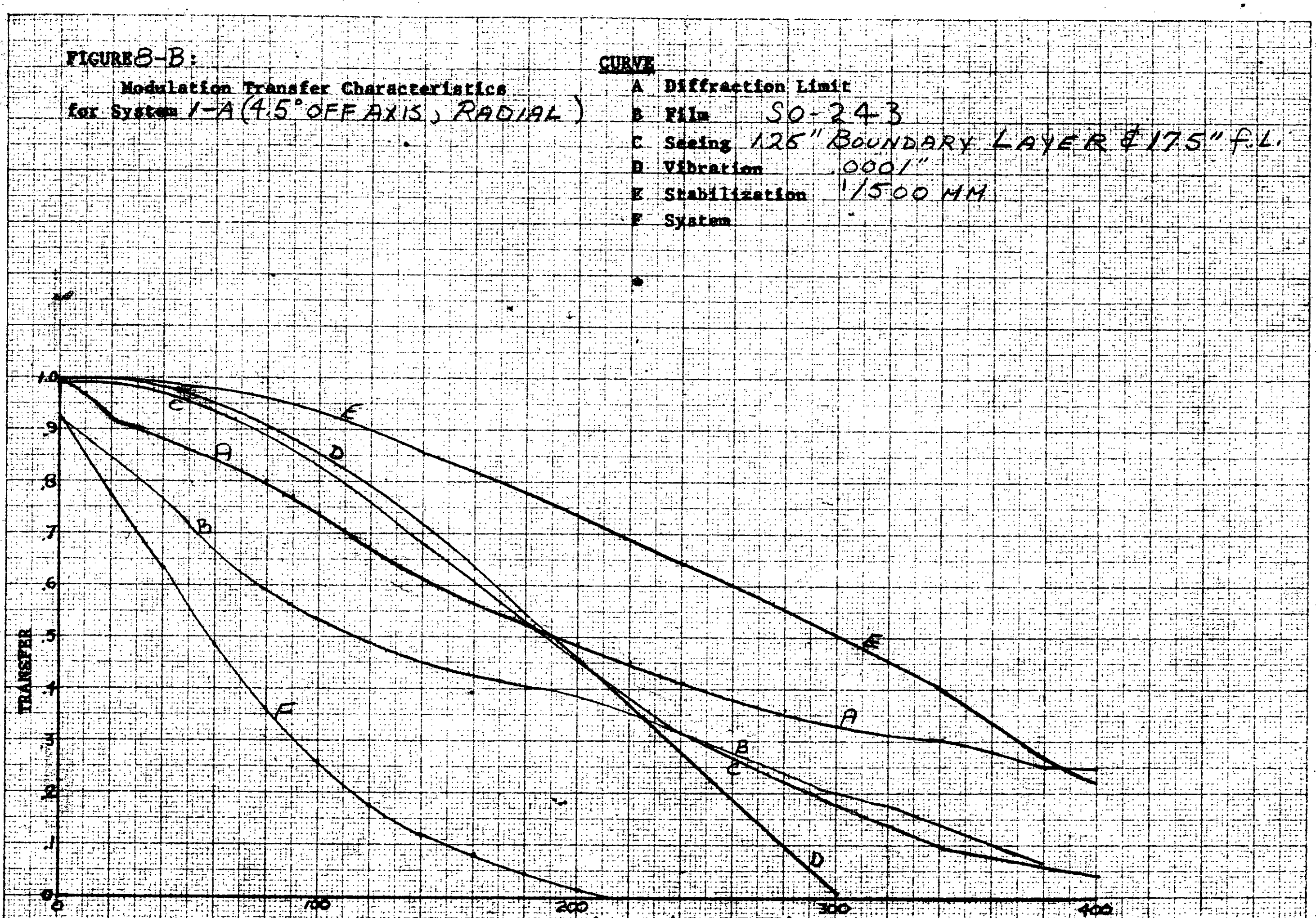
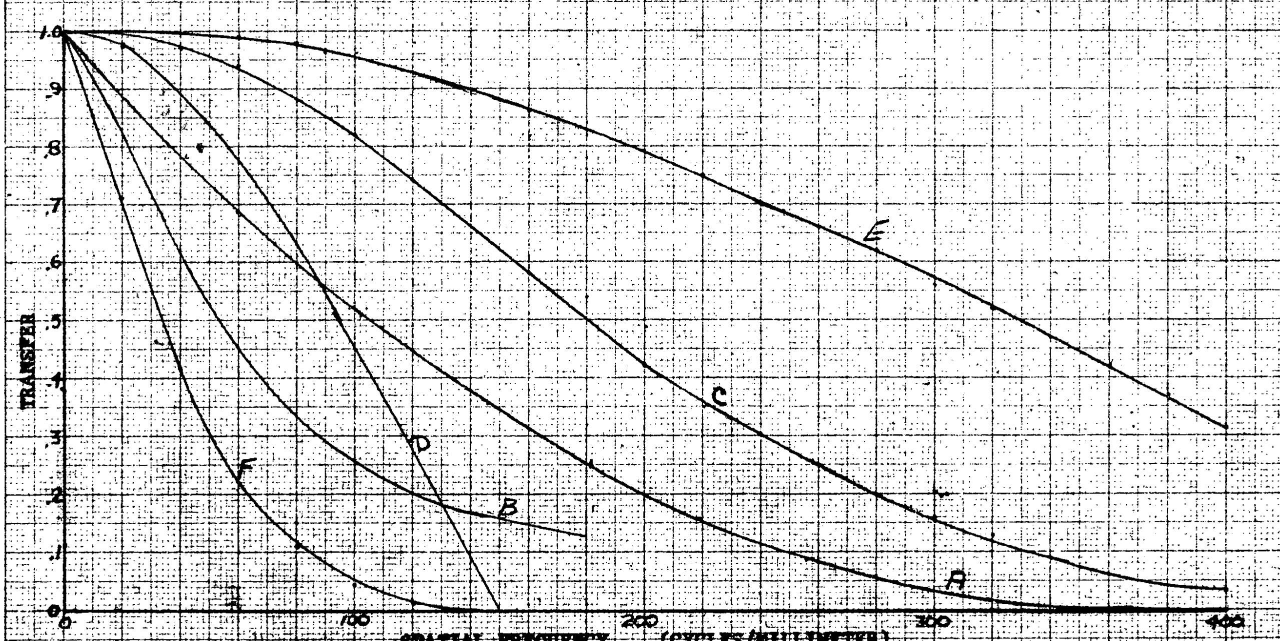


FIGURE 9 :
Modulation Transfer Characteristics for System 1-B

CURVE
A Diffraction Limit DIAGONAL OF APERTURE
B Film SO-182
C Seeing 1.25" BOUNDARY LAYER & 18" f.l.
D Vibration .0002"
E Stabilization 1/550 MM
F System



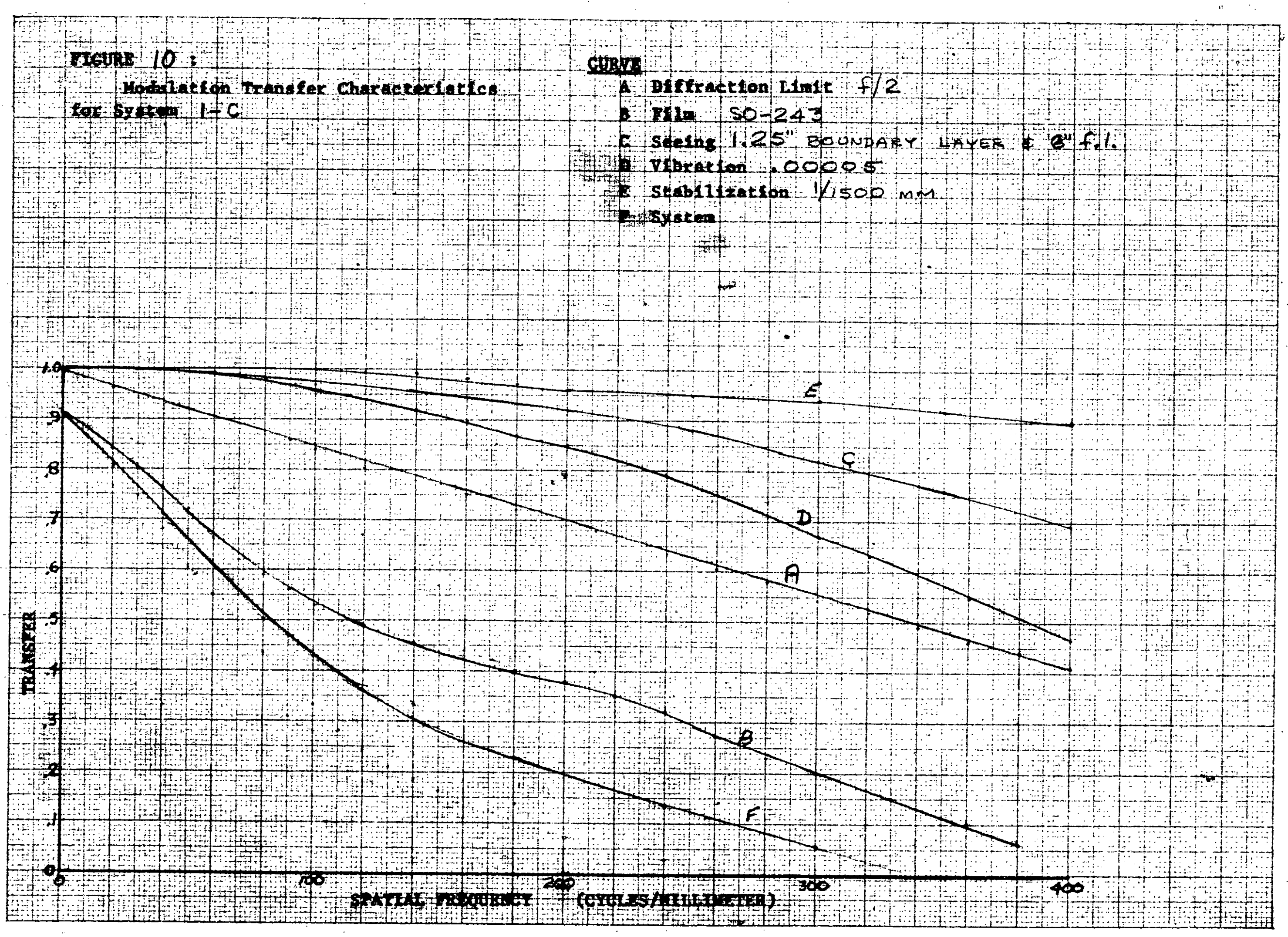


FIGURE 10 : Modulation Transfer Characteristics for System 1-C

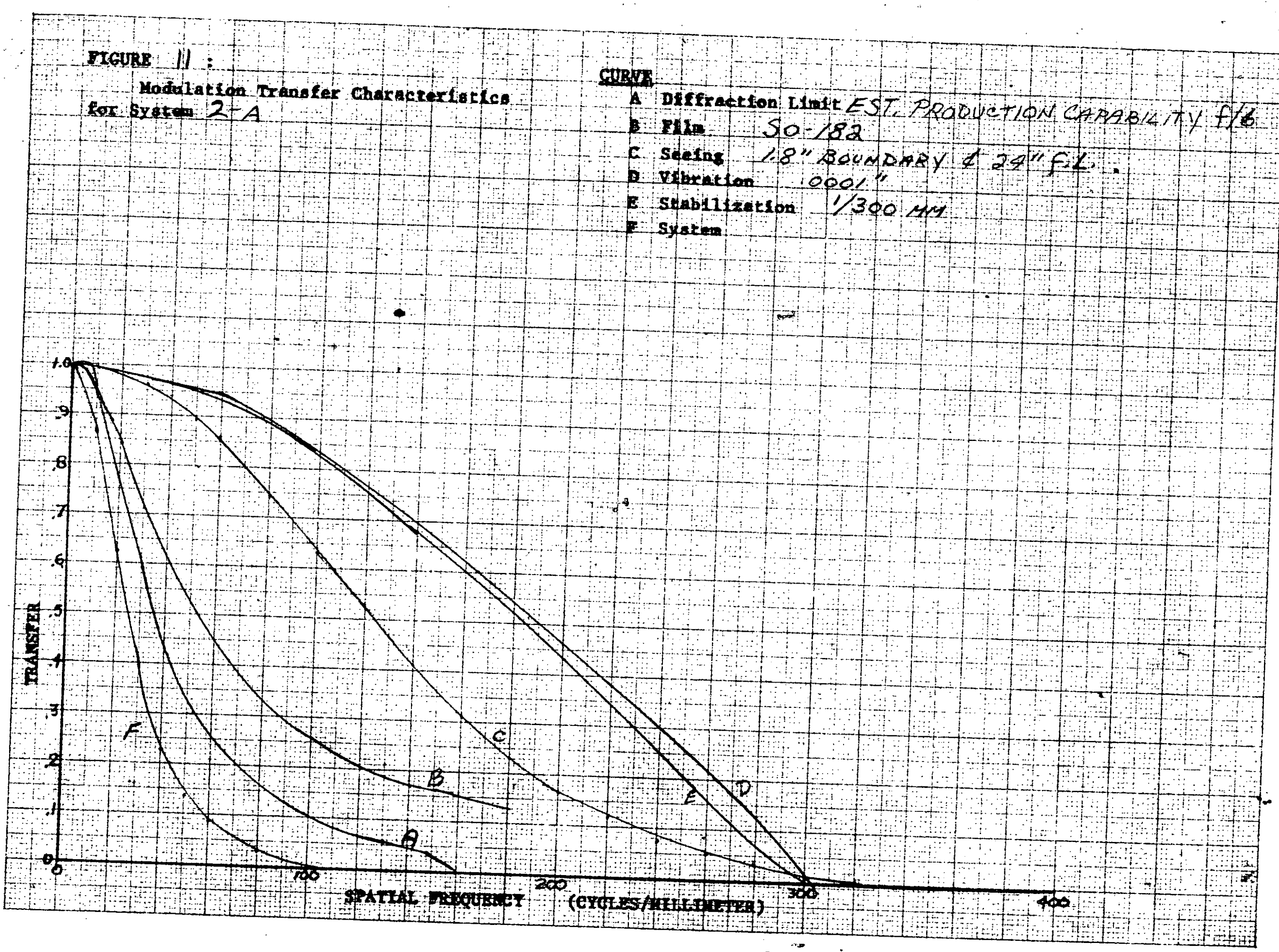


FIGURE 11 : Modulation Transfer Characteristics for System 2-A

FIGURE 12 ;
Modulation Transfer Characteristics for System 3-A

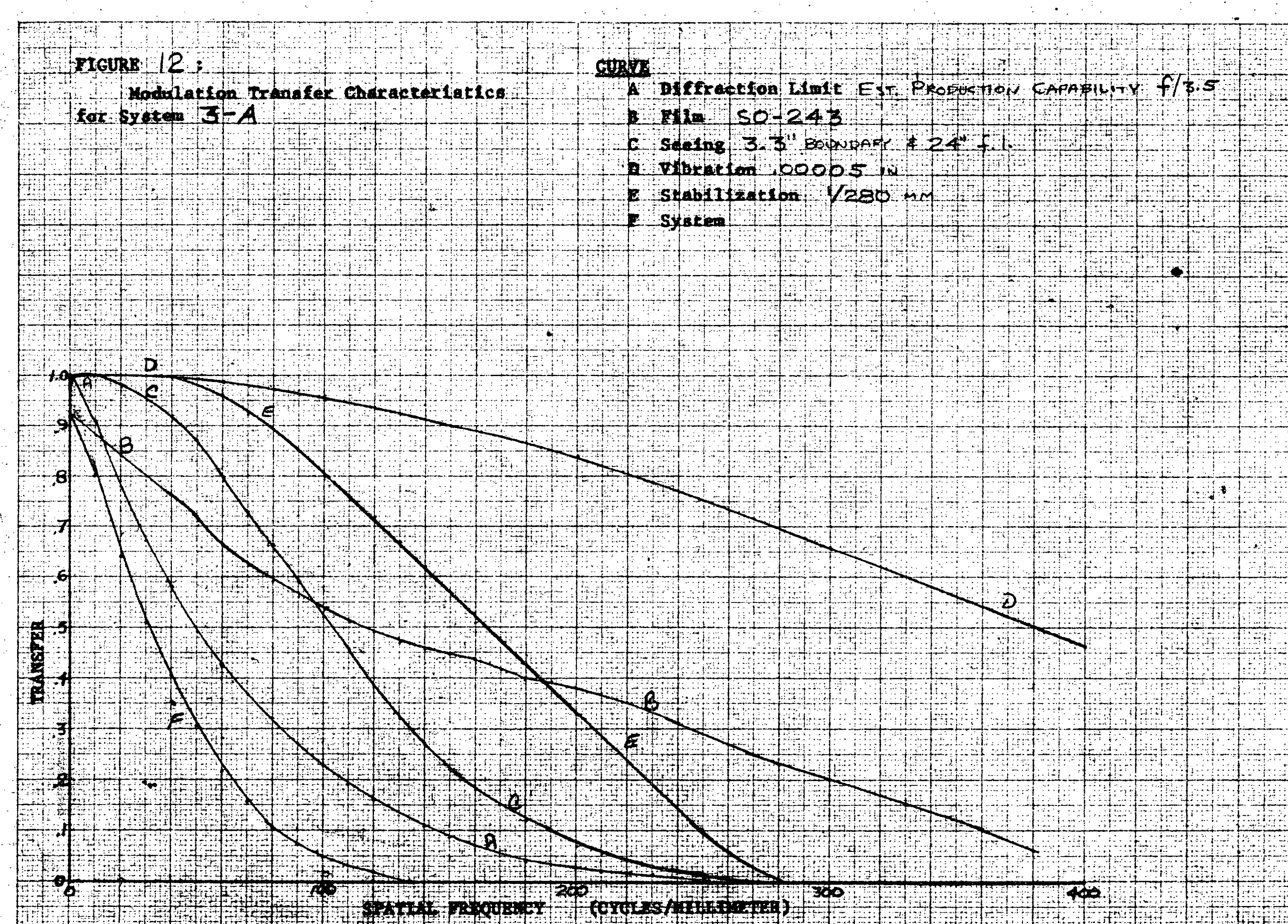
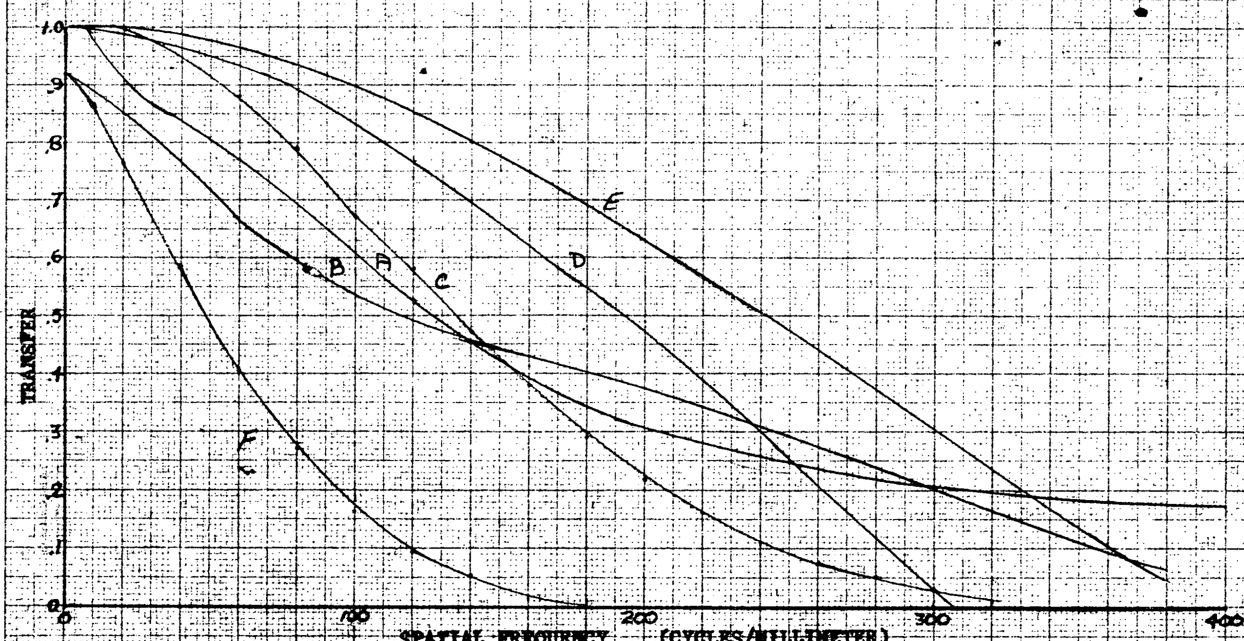


FIGURE 13:

Modulation Transfer Characteristics for System 4-A

CURVE
A Diffraction Limit 60.4% CENTRAL OBSCURATION
B Film SO-243
C Seeing 1.8" BOUNDARY LAYER & 22" F.L.
D Vibration .0001"
E Stabilization 1/400 MM
F System



Declassified in Part - Sanitized Copy Approved for Release 2012/06/18 : CIA-RDP89B00487R000400730032-7

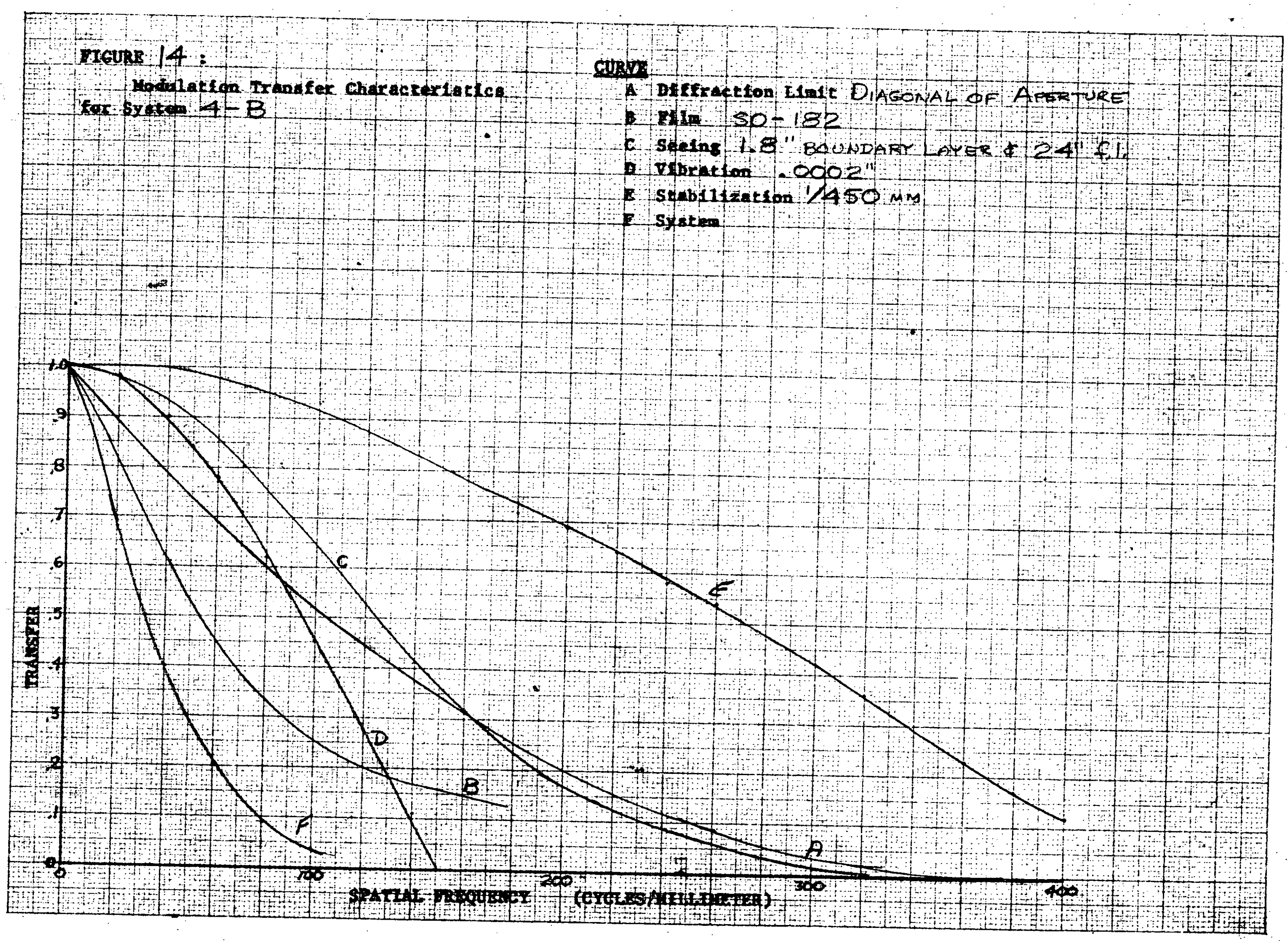


FIGURE 14 :
Modulation Transfer Characteristics
for System 4-B
CURVE
A Diffraction Limit DIAGONAL OF APERTURE
B Film SO-182
C Seeing 1.8" BOUNDARY LAYER & 24" C.L.
D Vibration .0002"
E Stabilization 1/450 MM
F System
TRANSFER
SPATIAL FREQUENCY (CYCLES/MILLIMETER)
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
100
200
300
400
A
B
C
D
E
F

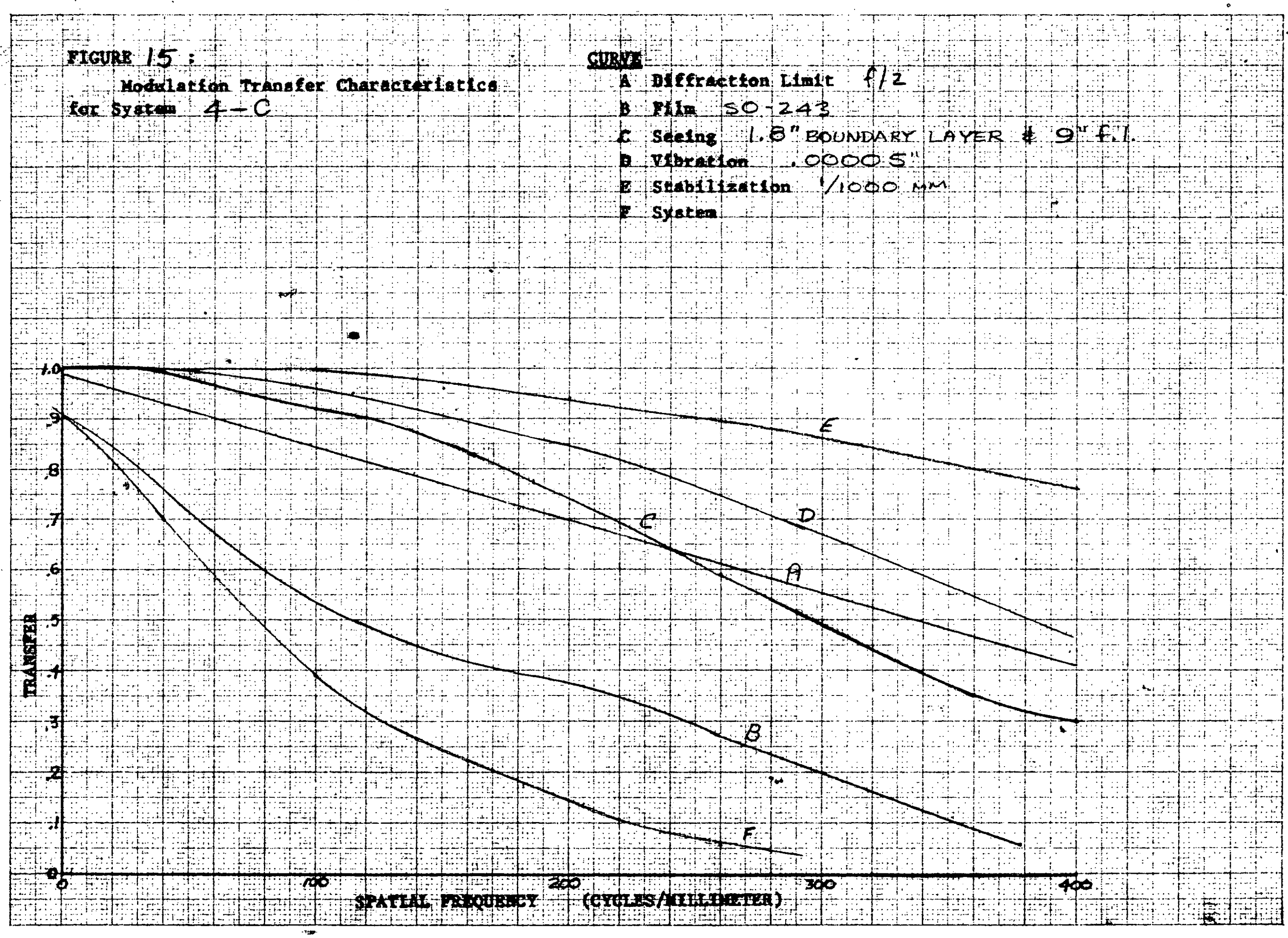
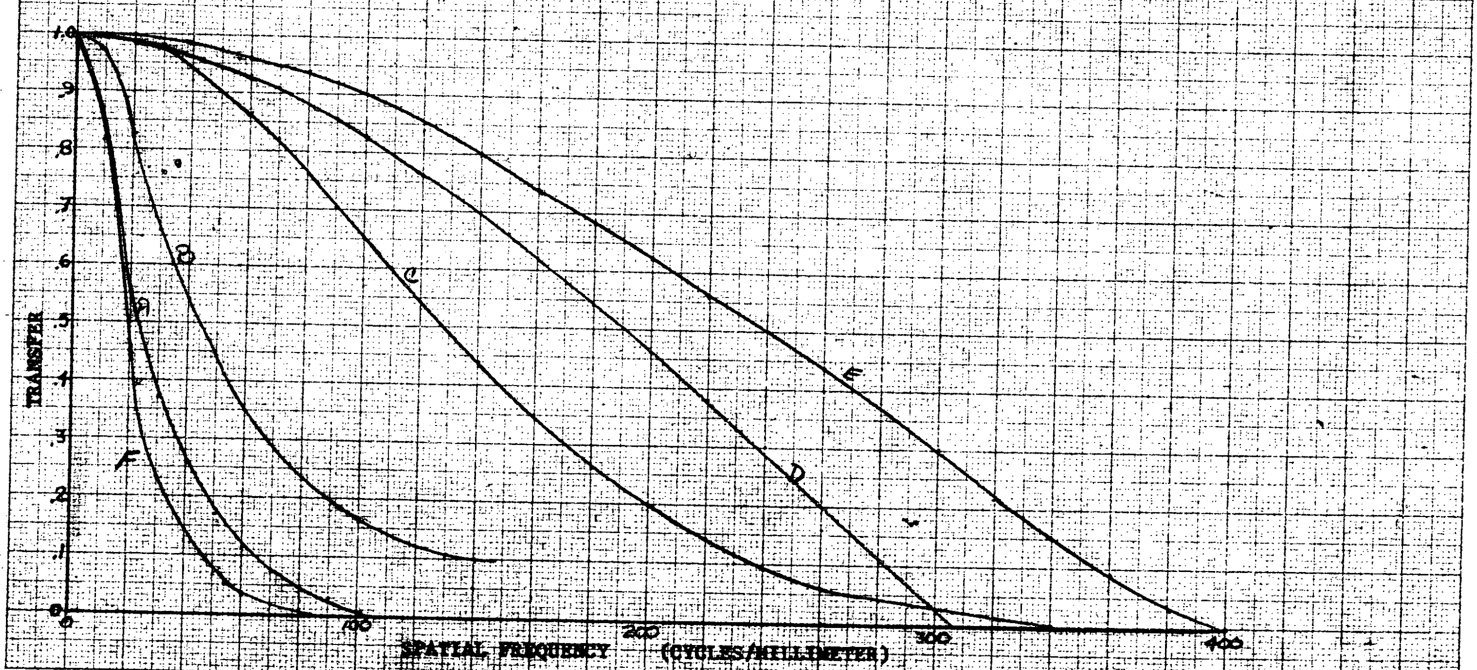


FIGURE 15 :
Modulation Transfer Characteristics
for System 4-C
CURVE
A Diffraction Limit f/2
B Film SO-243
C Seeing 1.8" BOUNDARY LAYER @ 9" f.l.
D Vibration .00005"
E Stabilization 1/1000 MM
F System
TRANSFER
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
0
100
200
300
400
SPATIAL FREQUENCY (CYCLES/MILLIMETER)
A
B
C
D
E
F

FIGURE 16 :
Modulation Transfer Characteristics
for System B - SYSTEM

CURVE
A Diffraction Limit ACTUAL B LENS - CENTER OF FIELD
B Film SO-153
C Seeing NO BOUNDARY & 36" f.l.
D Vibration .0001"
E Stabilization 1/400 MM
F System



Declassified in Part - Sanitized Copy Approved for Release 2012/06/18 : CIA-RDP89B00487R000400730032-7

APPENDIX B:

OUTLINES OF BAY VOLUME

FIGURE	VOLUME
17	Overall Layout
18	Volume 1
19	Volume 2
20	Volume 3
21	Volume 4

Declassified in Part - Sanitized Copy Approved for Release 2012/06/18 : CIA-RDP89B00487R000400730032-7

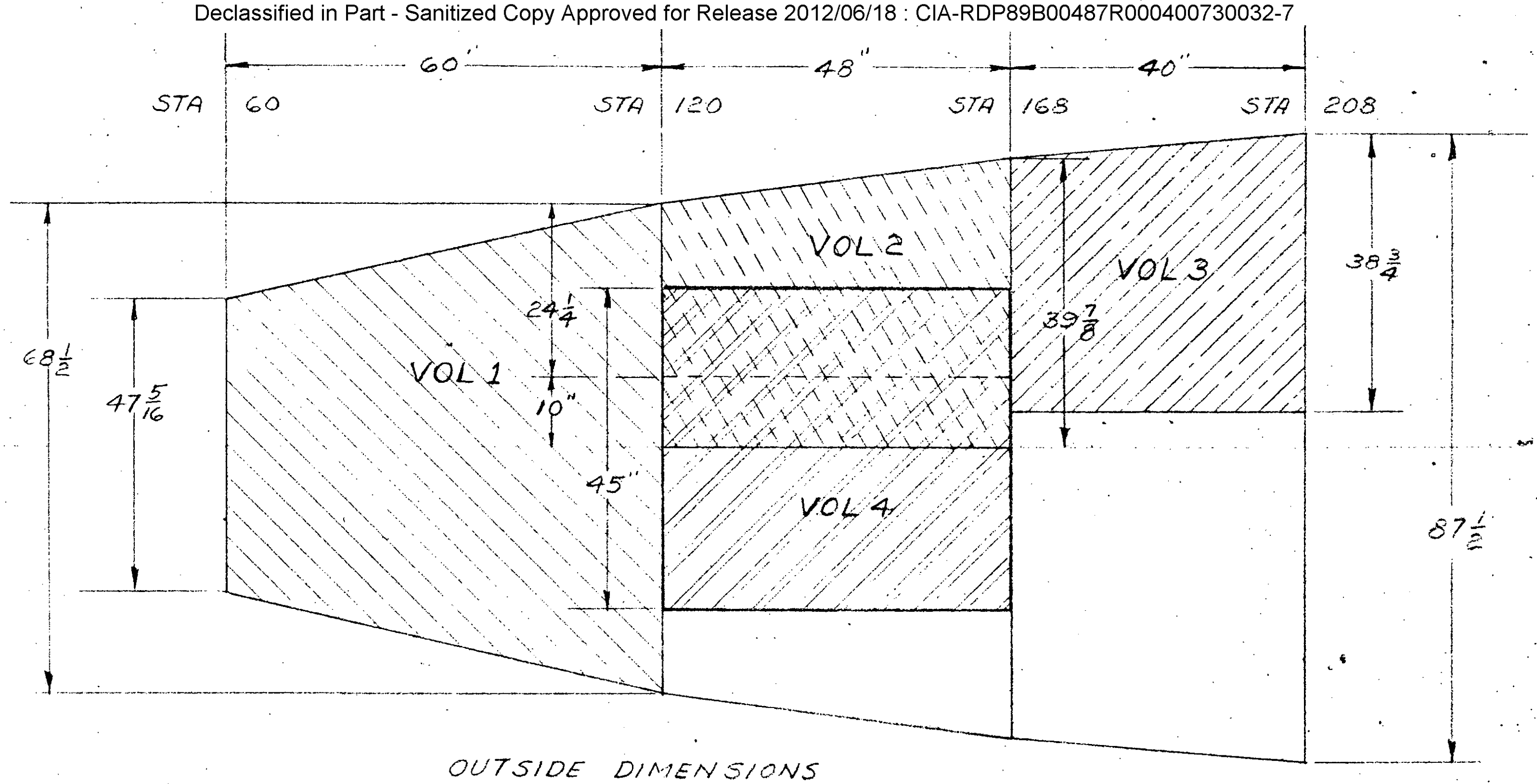
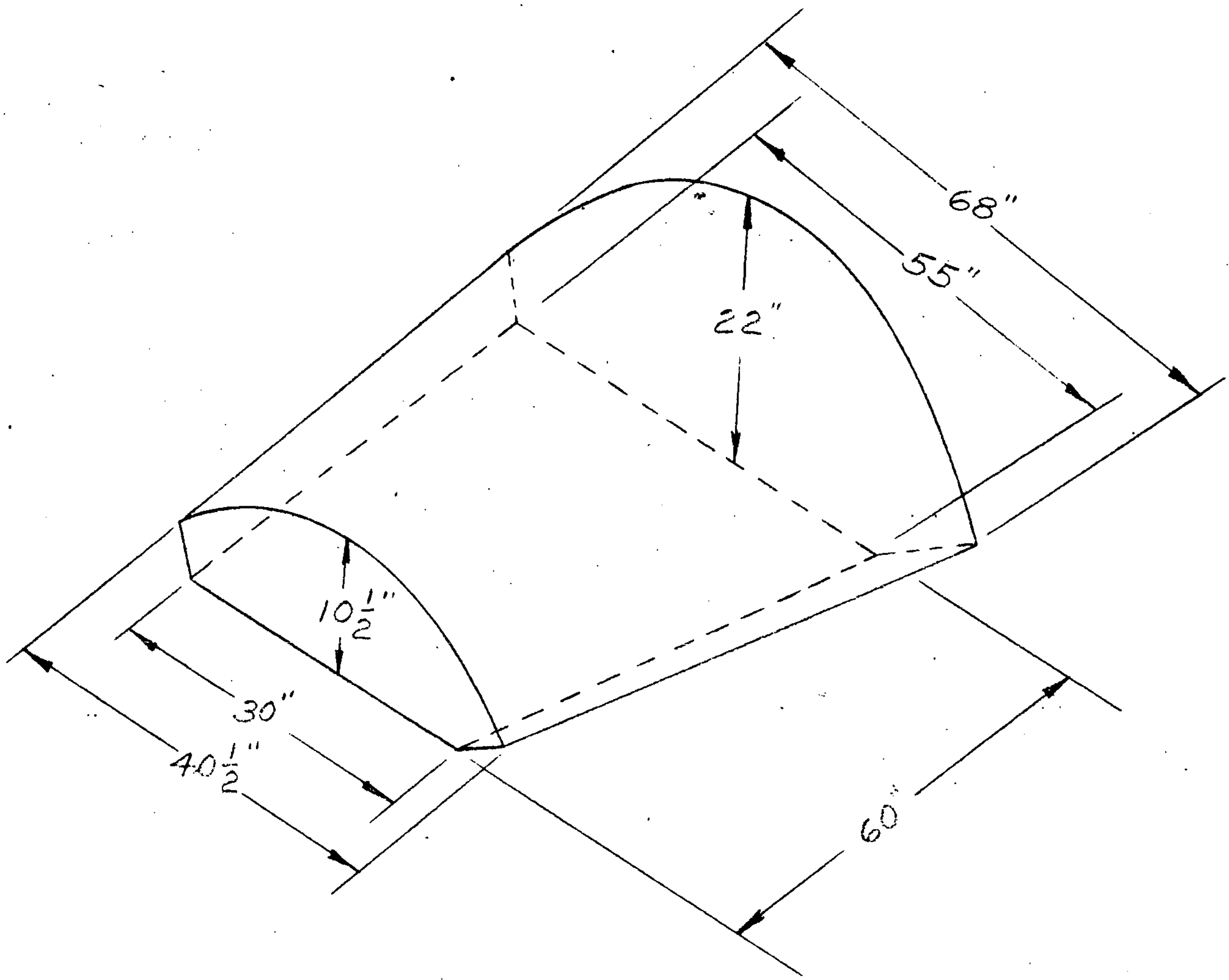


FIGURE 17 OVERALL LAYOUT

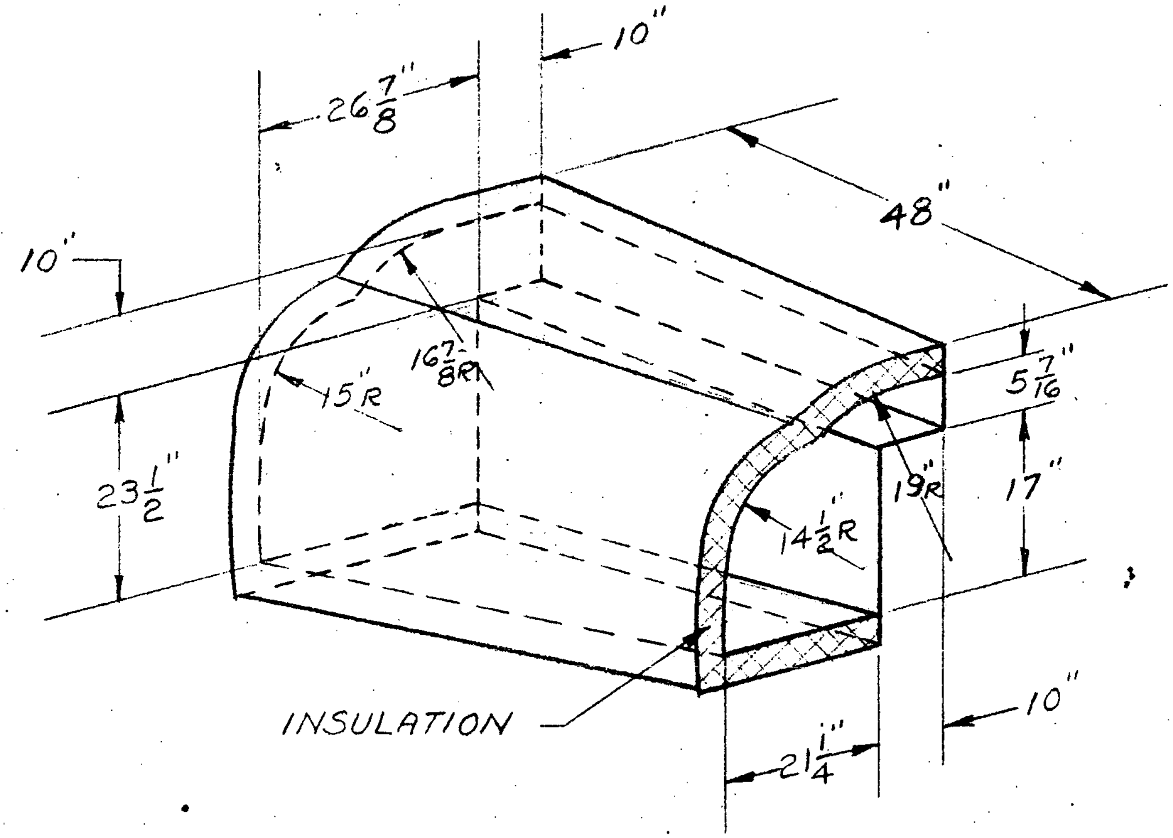
ER No. 5442



INSIDE DIMENSIONS

FIGURE 18

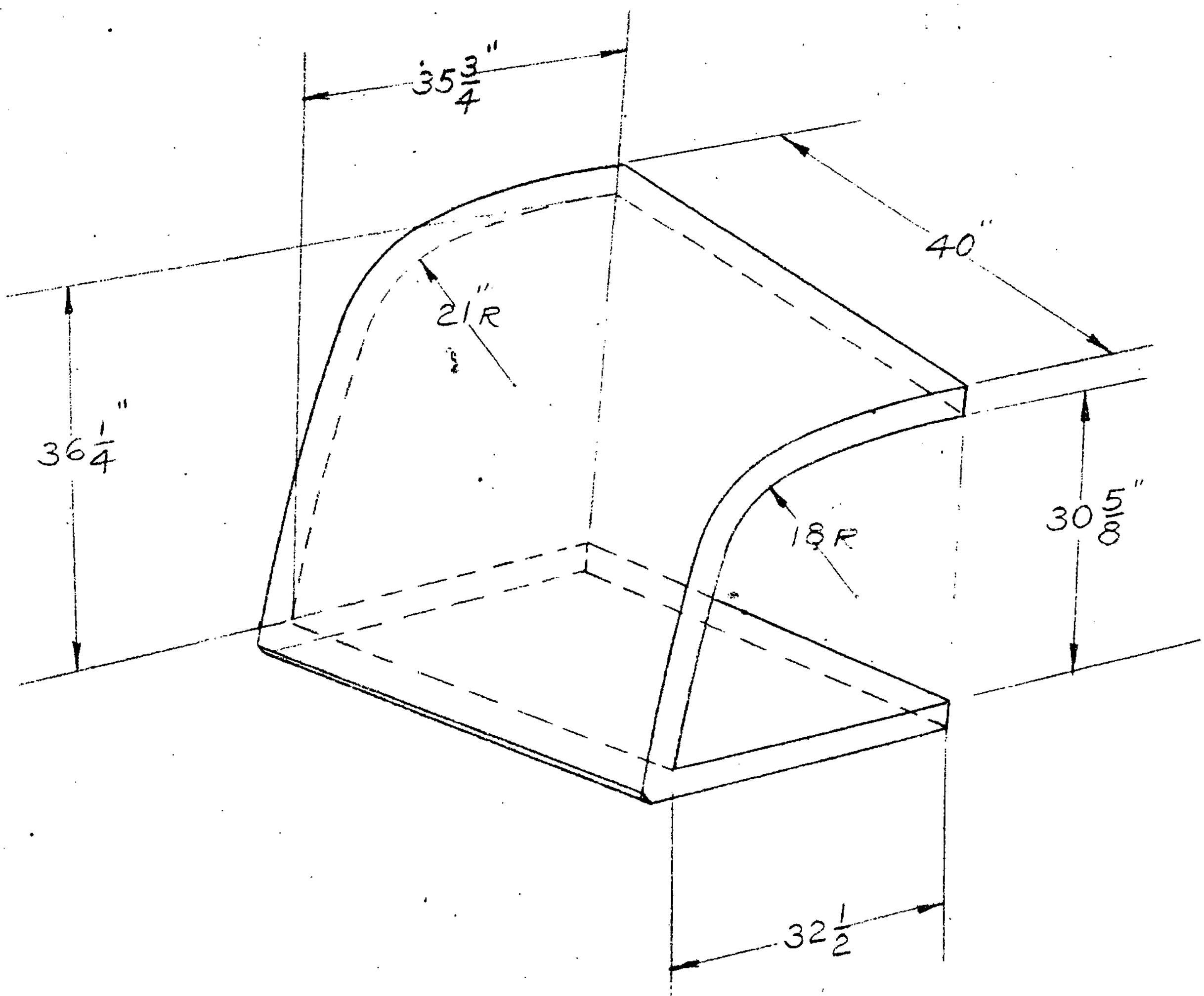
VOLUME 1



INSIDE DIMENSIONS

FIGURE 19

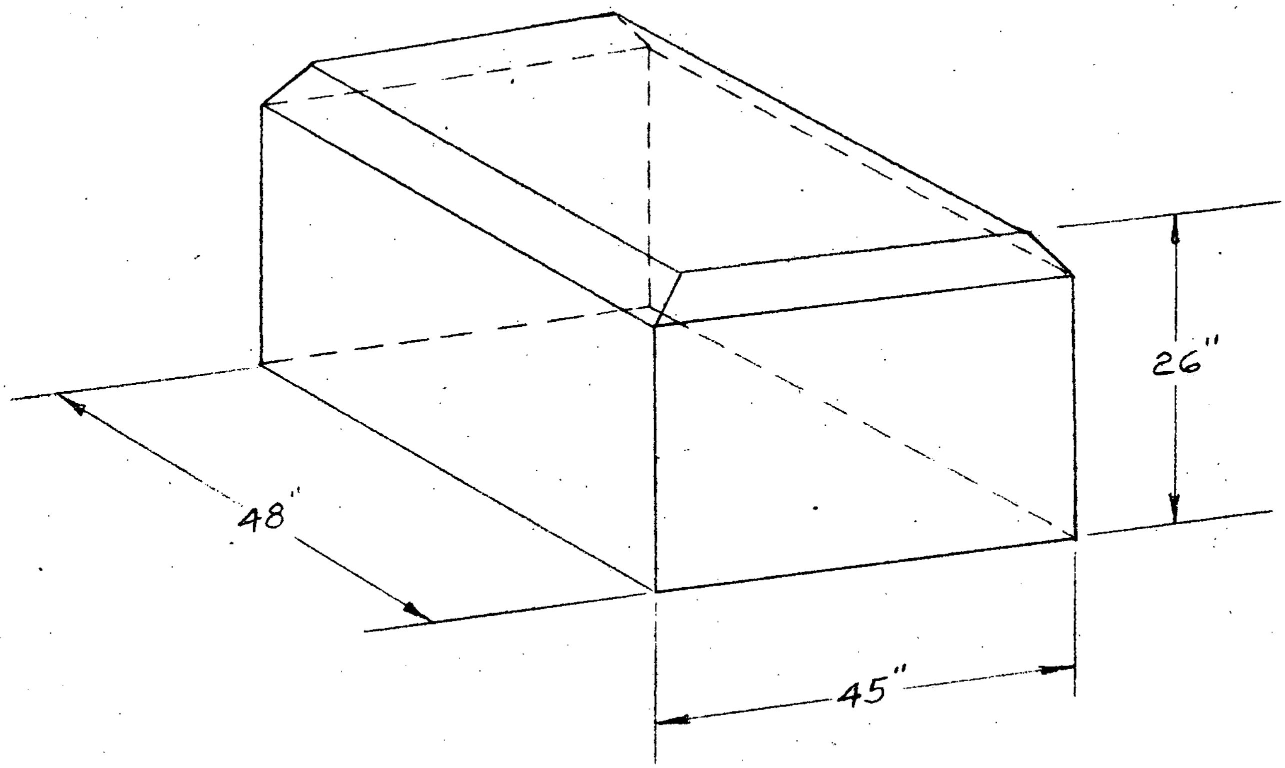
VOLUME 2



INSIDE DIMENSIONS

FIGURE 20 VOLUME 3

Declassified in Part - Sanitized Copy Approved for Release 2012/06/18 : CIA-RDP89B00487R000400730032-7



INSIDE DIMENSIONS

FIGURE 21

VOLUME 4

Declassified in Part - Sanitized Copy Approved for Release 2012/06/18 : CIA-RDP89B00487R000400730032-7

APPENDIX C:

LENSES & INSTALLATIONS

FIGURE 22 SIDE VIEW 17.5" FLÜGGE, INSTALLED

E.R. No 5442

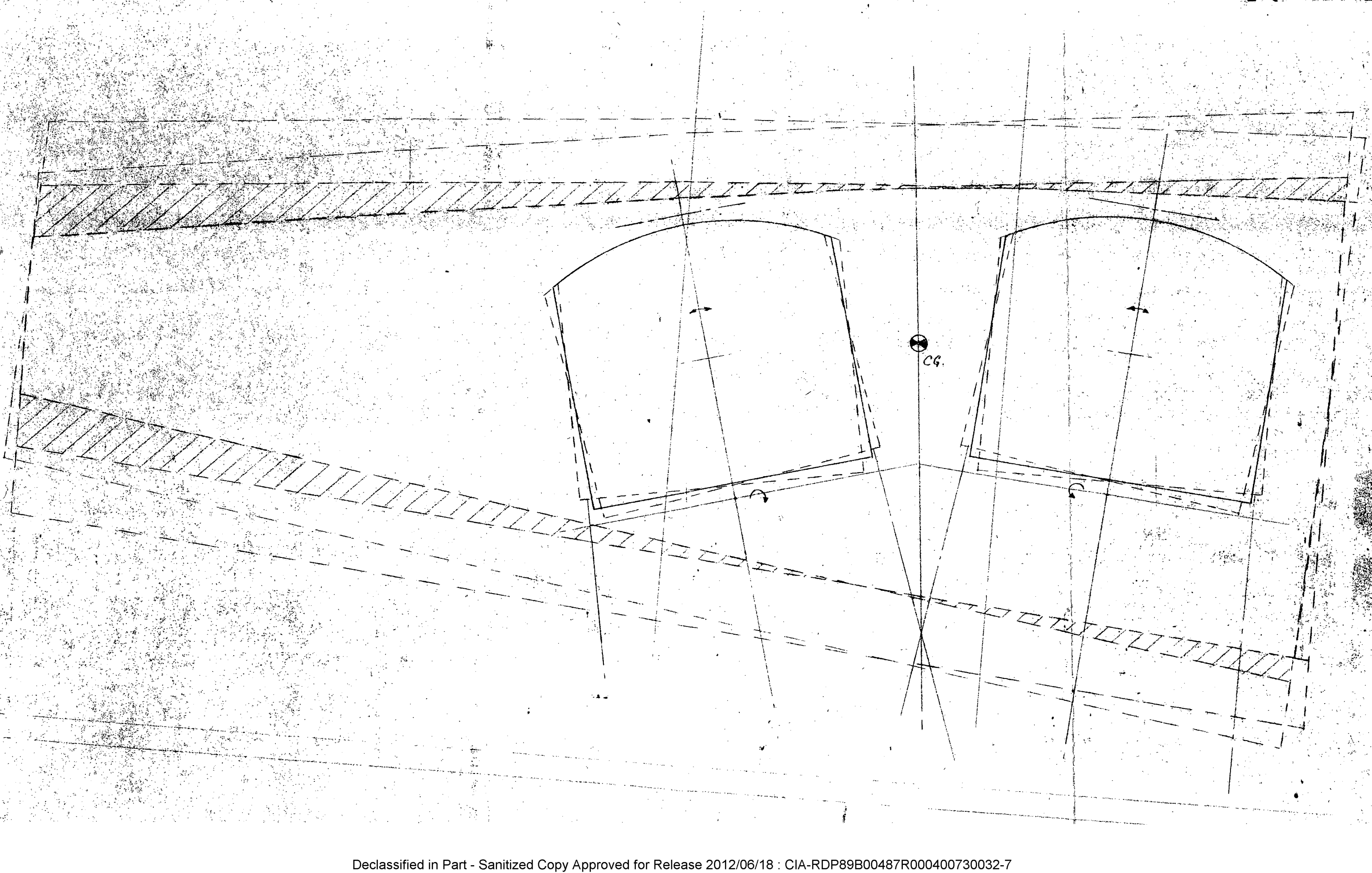


FIGURE 23

FRONT VIEW 17.5" FLUGGE INSTALLED

E.R. No 5442

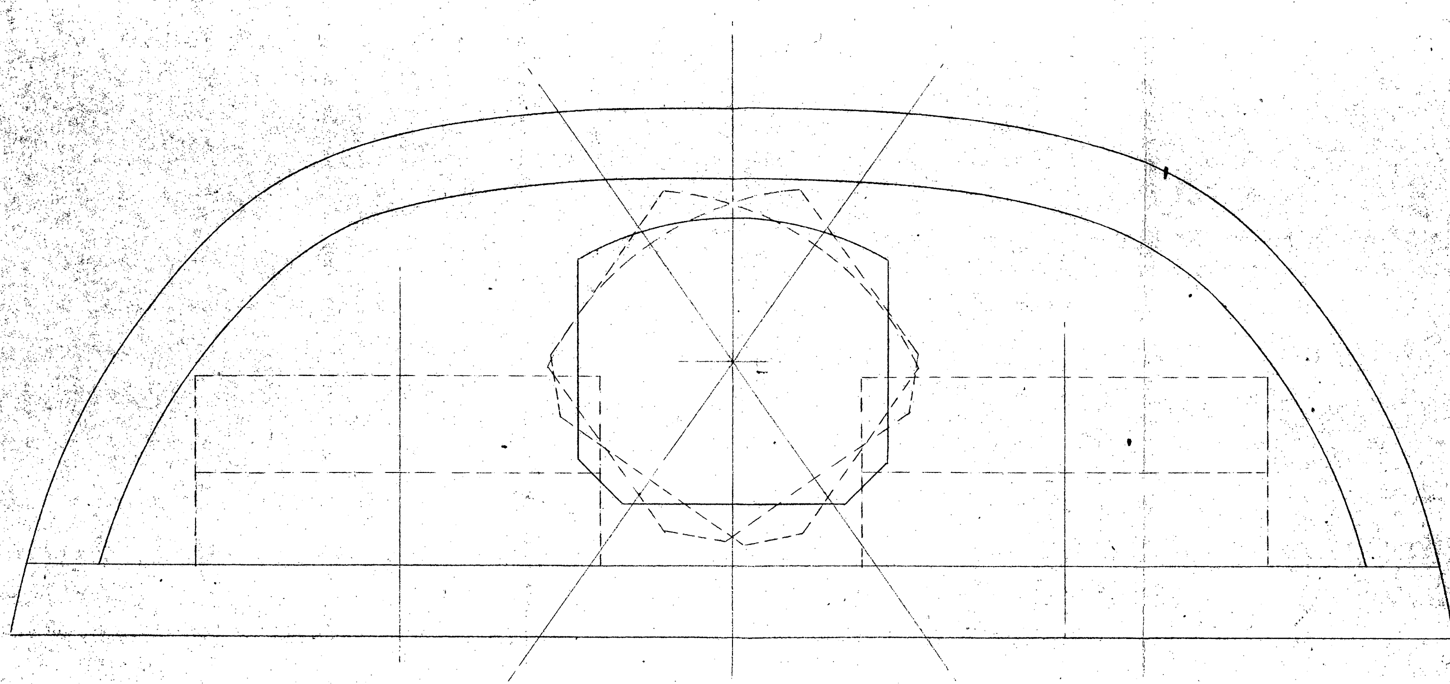
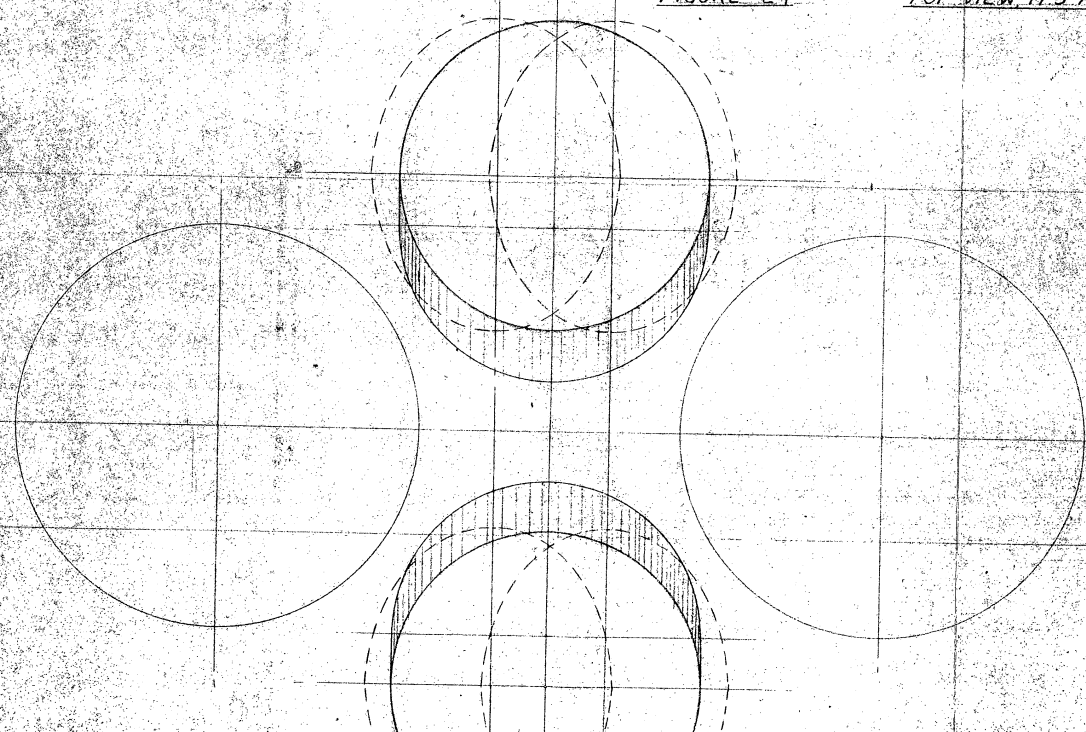


FIGURE 24

TOP VIEW, 17.5' FLUGGE, INSTALLED

E.R. No 5442



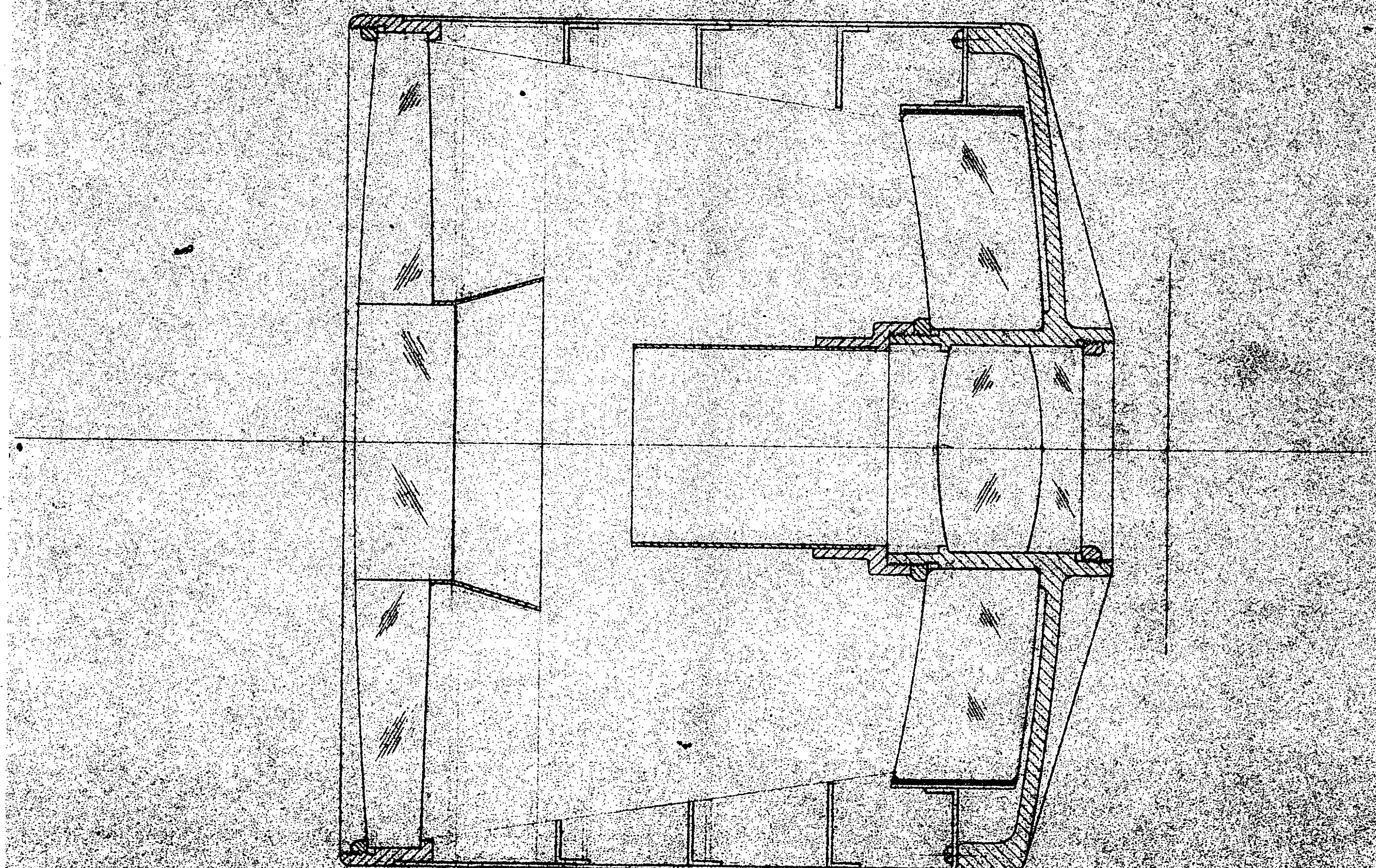
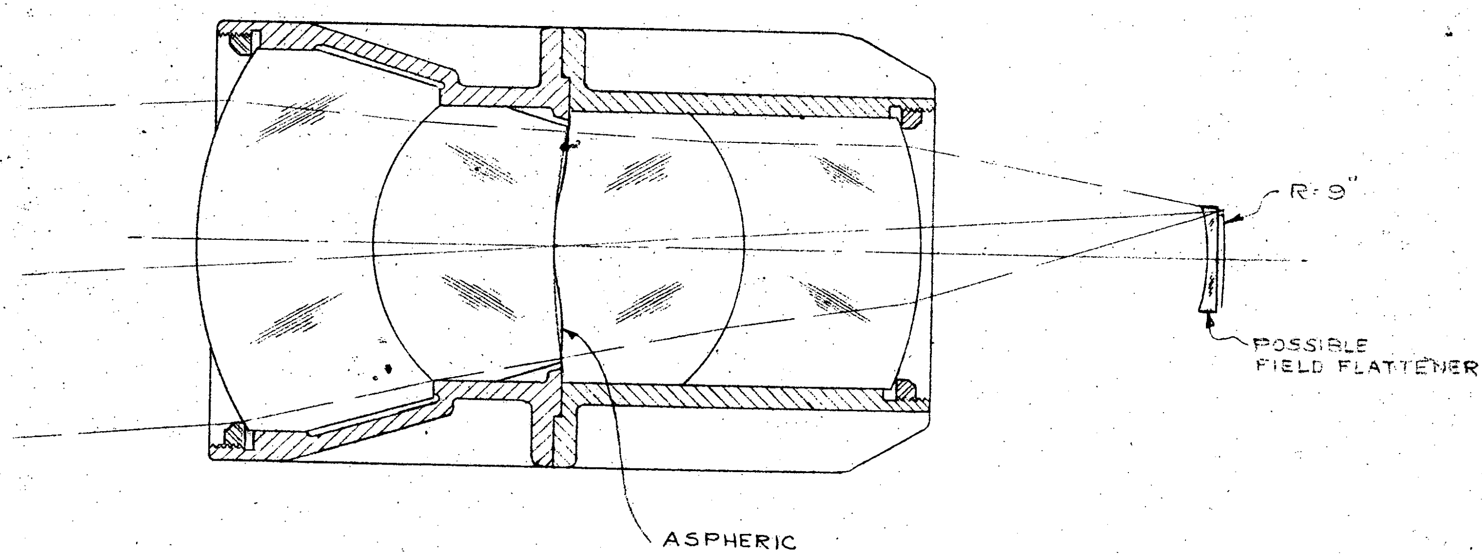


FIGURE 25 FLUGGE LENS WITH BAFFLES

ER No. 5442

f/2⁺ "BALL" LENS



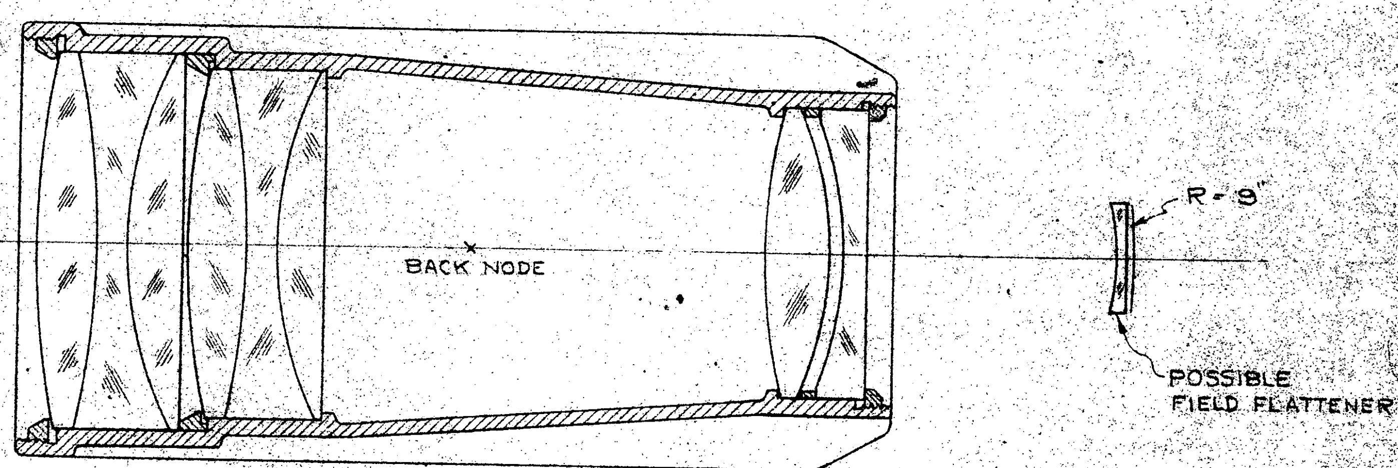
½ SCALE FOR 9" EFL

FIGURE 26

BALL LENS

ER No 5442

f/2+ PETZVAL LENS



SECONDARY SPECTRUM
IS 1/4 THAT OF A
NORMAL THIN ACHROMAT

1/2 SCALE FOR 9" EFL

FIGURE 27 PETZVAL LENS

ER No 5442

FIGURE 28'

SIDE VIEW 24' SHELL-SCHMIDT 5° ATTACK ANG

E.R. No 5442

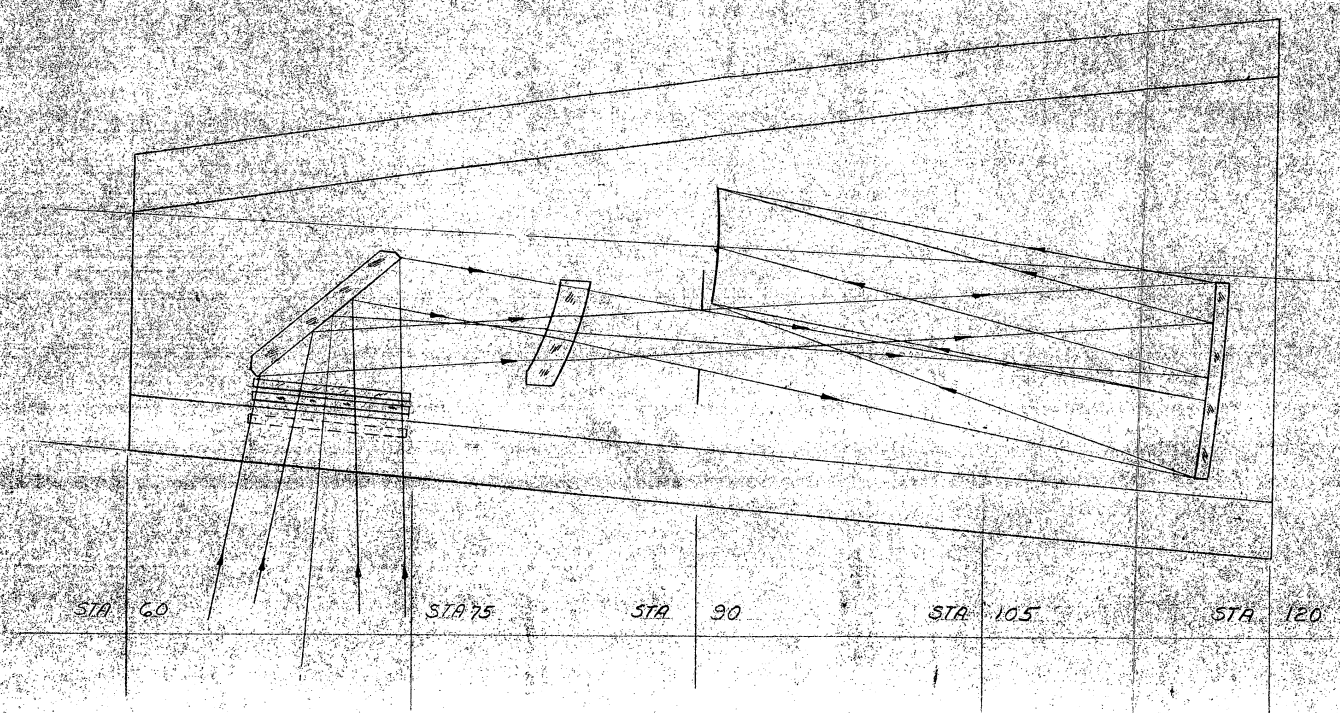


FIGURE 29

SIDE VIEW 24" SHELL-SCHMIDT-8° ATTACK ANGLE

E.R. No. 5442

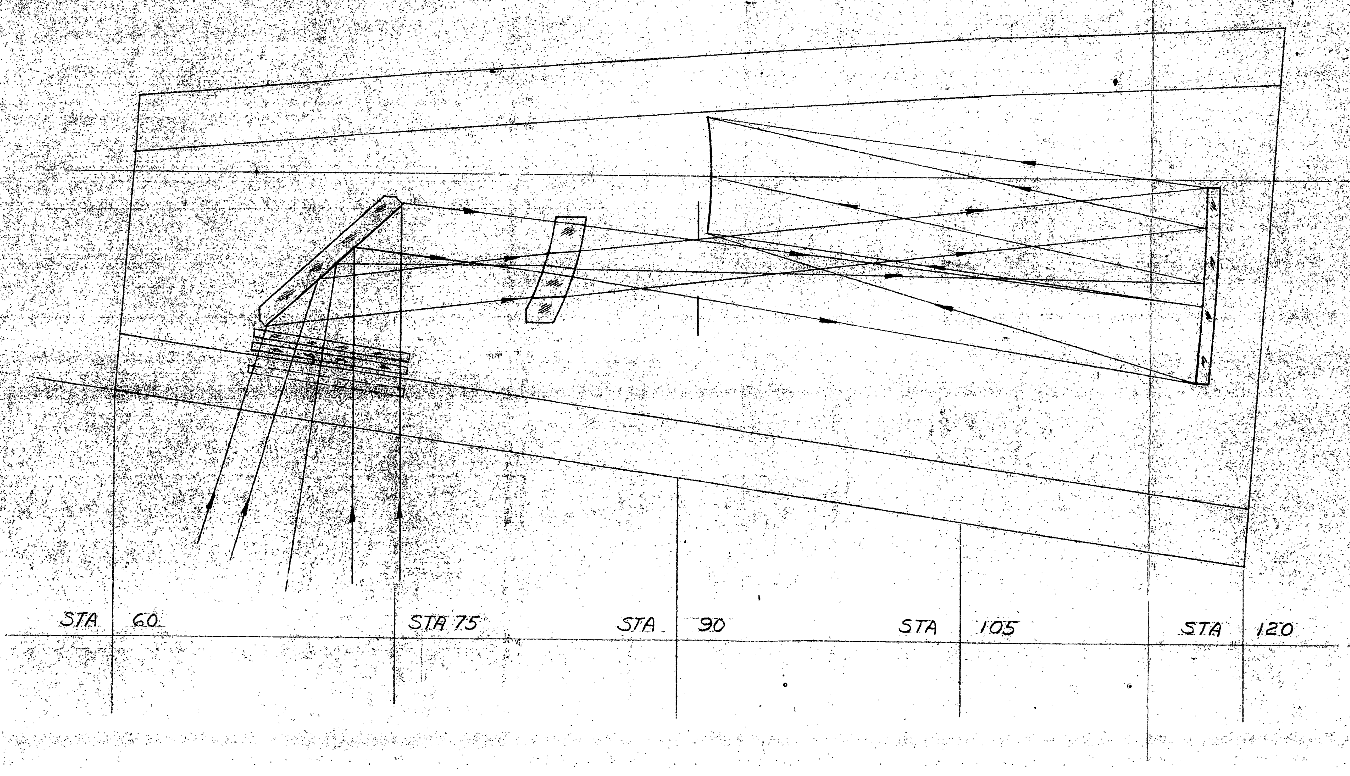


FIGURE 30

FRONT VIEW, 24" SHELL-SCHMIDT

ER No5442

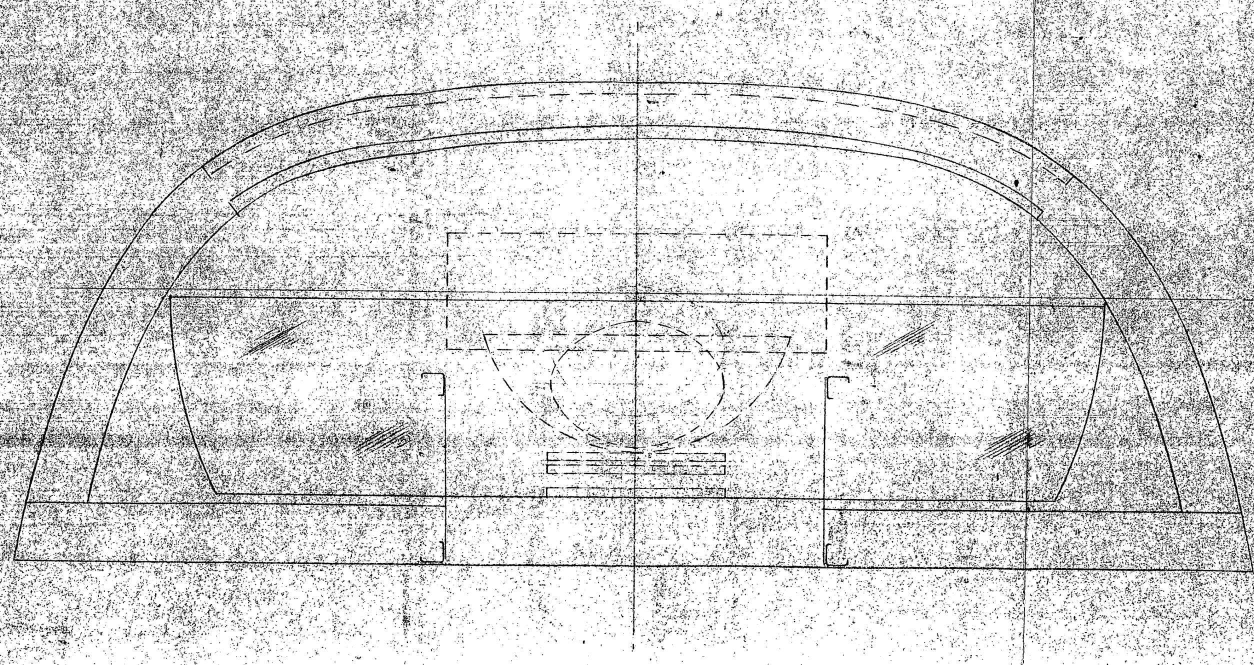
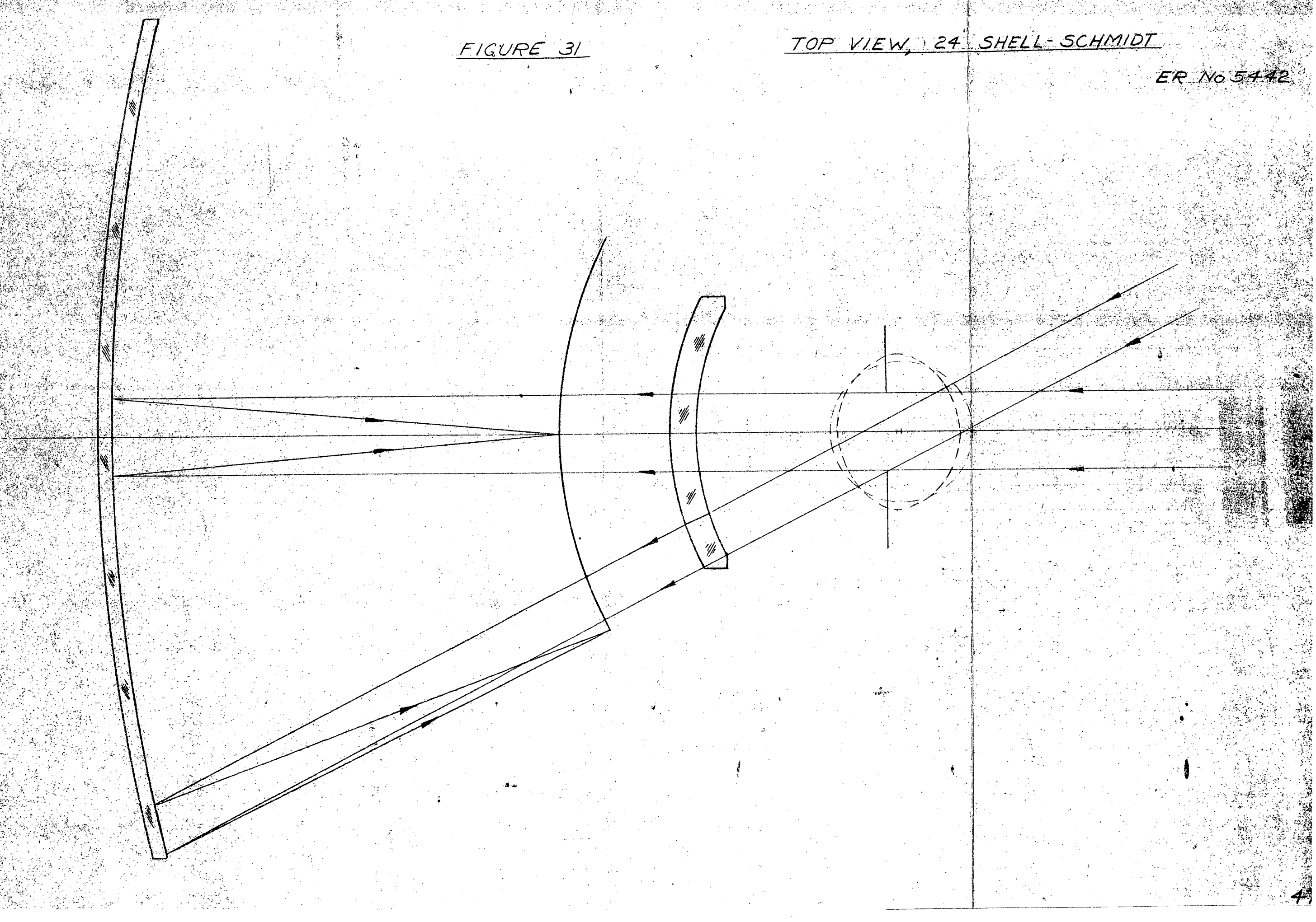


FIGURE 31

TOP VIEW, 24" SHELL-SCHMIDT

ER No 5442



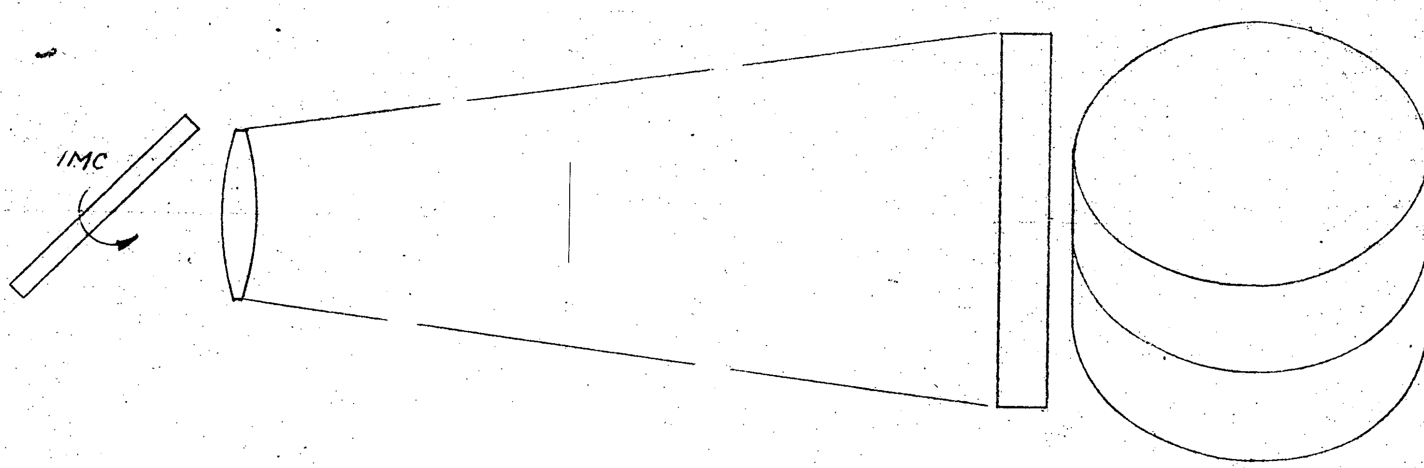


FIGURE 32 GENERAL ARRANGEMENT, SYSTEM 2-A

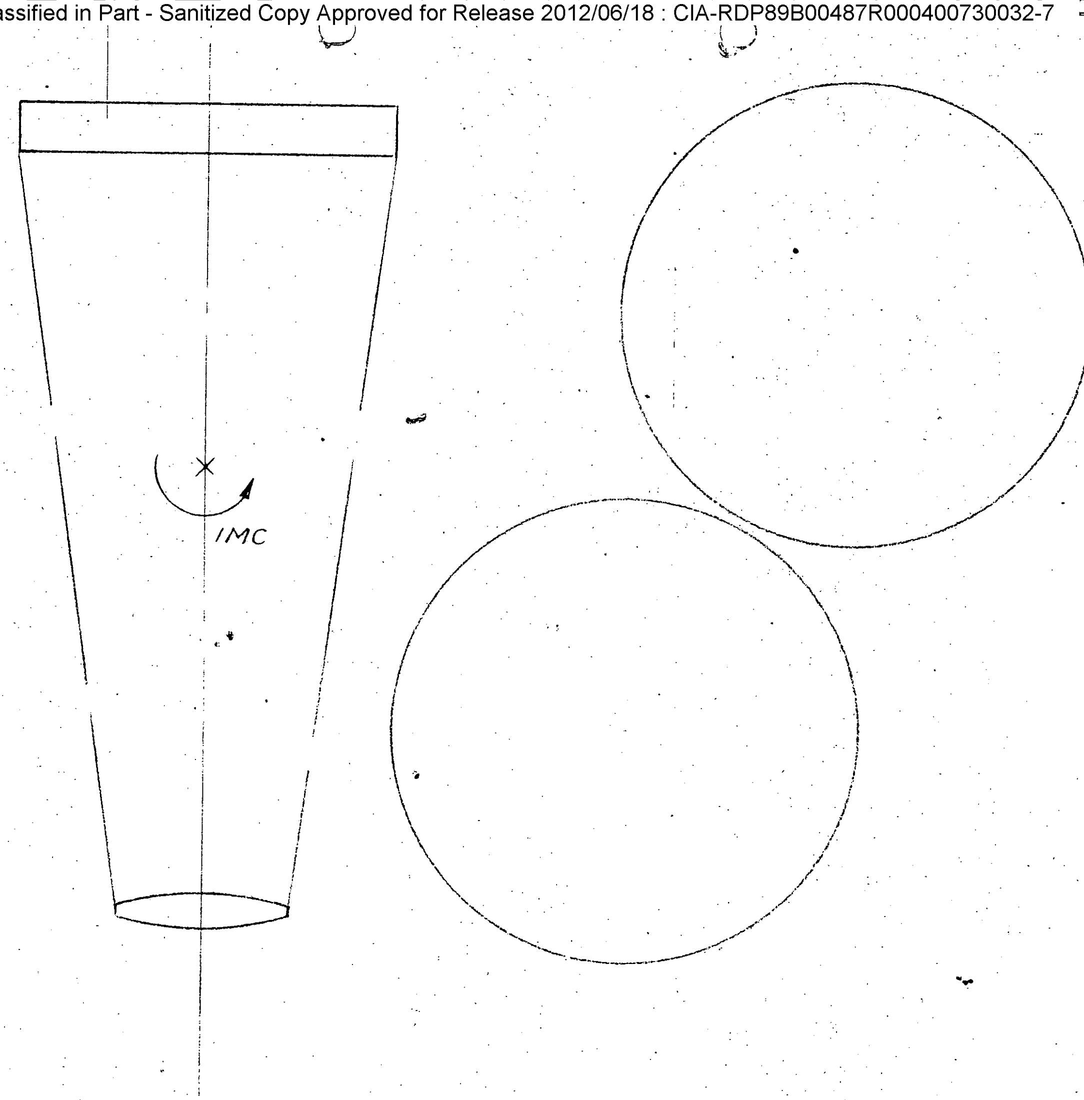


FIGURE 33 GENERAL ARRANGMENT, SYSTEM 3-A

FR No 5442

APPENDIX D

OPTICAL ANALYSIS OF 24 INCH f/6 SHELL SCHMIDT SYSTEM

BAKER 24" f/6 SHELL SYSTEM

The first step in examining the potentialities of this wide-angle (60^o) system consisted of strengthening the shell to reduce, but not entirely remove, the spherical aberration at 0^o field. Next, an asphericity of fourth degree was applied to the second surface of the crown element (located at the common center of curvature of shell and mirror). The amount of asphericity was chosen to remove the third order residual of spherical undercorrection. As would be expected, ray-tracing indicated a considerable amount of spherical overcorrection, and this was removed with undercorrecting terms in the aspheric polynomial of sixth, eighth, and tenth degree.

While making the trials to evaluate these terms, it was necessary to examine the performance of the system both axially and at an arbitrarily chosen field angle of 25^o. Sets of 35 rays equally distributed over the f/6 pupil area were used, and the "focus" was selected to minimize the spread of the rays. In addition to these two field angles, ray-bundles were traced at $+6^o$ and -6^o in the Z direction (film-width direction). Although perhaps a little more optimizing of the aspheric would be called for, nevertheless all field angles traced showed a concentration of at least 80% of the aperture within a diameter of 10 microns, and some within 5 microns.

It should be noted that this investigation was purely monochromatic in order to save time. It is very likely however that chromatic effects can be thoroughly corrected since the first-order powers of the doublet elements at the center of curvature take care of the primary contributions of the shell, and a proper division of the asphericity between crown and flint should be sufficient to take care of the higher-order chromatic errors. The aspheric curve arrived at (before high-order achromatization) has zero vertex curvature, a maximum elevation equal to 25 waves of green light occuring at 85% of the f/1.4 aperture, and an edge elevation of 7 waves of green light. After achromatization, one element would carry an asphericity of about this same strength, and the other would carry one about twice as strong.

APPENDIX E

LISTING OF PERTINENT REPORTS

The following is a list of pertinent reports concerning this program:

DATE	NUMBER	TITLE
1 February 1959	——	Aerial Reconnaissance System Progress Report No. 1
2 March 1959	5394	High Acuity Reconnaissance Systems for A High Performance Aircraft
30 March 1959	——	Letter from JGB to Program Director
13 April 1959	5414	[redacted] Project Plan 13 April - 30 June 1955 STAT
1 May 1959	5424	[redacted] Progress Report No. 1 14-30 April 1959 STAT

STAT

DOCUMENT # 4

COPY # 2 OF 10 DAN

DO NOT REPRODUCE

STAT

Declassified in Part - Sanitized Copy Approved for Release 2012/06/18 : CIA-RDP89B00487R000400730032-7